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THE MEASUREMENT OF THE DC-7 TRAILING VORTEX SYSTEM USING THE TOWER FLY-BY TECHNIQUE

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Atlantic City, New Jersey

November 1973

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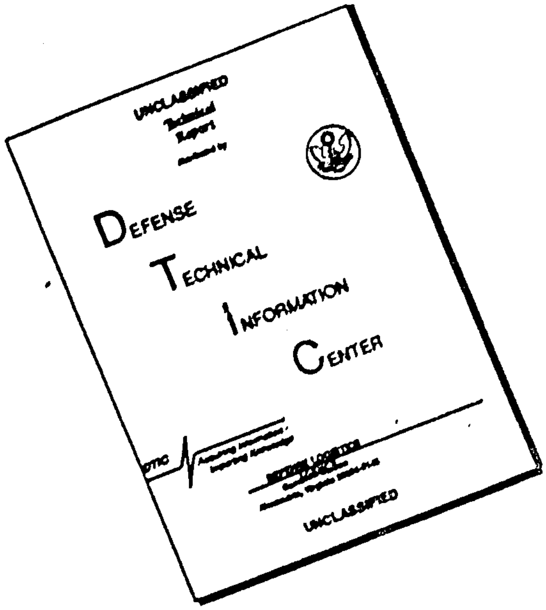

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AD 771 214

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FAA-RD-73-141		

4. Title and Subtitle	5. Report Date
THE MEASUREMENT OF THE DC-7 TRAILING VORTEX SYSTEM USING THE TOWER FLY-BY TECHNIQUE	November 1973
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Leo J. Garodz Nelson J. Miller, David Lawrence	FAA-NA-73-34
9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Federal Aviation Administration National Aviation Facilities Experimental Center Atlantic City, New Jersey 08405	11. Contract or Grant No. 214-531-070
	13. Type of Report and Period Covered Final April - September 1971
12. Sponsoring Agency Name and Address	14. Sponsoring Agency Code
Department of Transportation Federal Aviation Administration Systems Research and Development Service Washington, D. C. 20590	

15. Supplementary Notes

16. Abstract

This report describes the technique and presents the results of a series of full-scale flight tests performed at NAFEC in September 1971, in which the wing trailing vortices of the Douglas DC-7 airplane were investigated by flying the airplane at low altitude, upwind of, and in close proximity to a 140-foot instrumented tower. Tower instrumentation consisted of hot-film anemometers located at 4-foot intervals and wind velocity and direction sensors. Vortex air flow visualization was by use of colored smoke. The aircraft was tracked by the National Aviation Facilities Experimental Center's Phototheodolite Facility. The data consists of tangential velocity distribution plots, peak recorded velocity as a function of time, airplane configuration and wind; vortex vertical and lateral transport velocities, and specimen time histories of the velocities recorded at individual sensors. The principal findings were: (1) Peak absolute velocity, associated with the vortex core, decays exponentially; (2) Vertical transport velocities of the vortices do not correlate well with those predicted by potential flow theory; (3) Lateral transport velocities correlate fairly well with values obtained from theory; and (4) The resolution possible with 4-foot spacing of the hot-wire anemometers is insufficient to precisely define vortex core size of the subject airplane.

17. Key Words	18. Distribution Statement
Wake Turbulence Trailing Vortices Full-Scale Flight Tests Hot-Film Anemometry	Document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	~~374~~ 382	

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PREFACE

The characteristics of the trailing vortex system of the DC-7 airplane have been investigated by the National Aviation Facilities Experimental Center (NAFEC) during a series of flight tests conducted during September 1971. These tests were conducted in support of a Federal Aviation Administration program to demonstrate the feasibility of a bi-static acoustic Doppler sensor for vortex measurement. This report covers the vortex flow measurements made and characteristics noted by NAFEC, using the NAFEC Instrumented Vortex Flow Measurement Tower and the tower fly-by technique.

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INTRODUCTION

PURPOSE.

The work described in this report was performed with the intention of gaining a better understanding of the structure and behavior of the wake of a relatively large propeller-driven transport airplane, in this case, the Douglas DC-7 airplane (Figures 1 and 2). The possibility exists of further application of the test results to proposed STOL terminal area operations with large propeller-driven STOL airplanes, such as the Breguet 941 (McDonnell-Douglas 188).

BACKGROUND.

The Federal Aviation Administration (FAA) has a continuing program underway, the purpose of which is to safely increase air traffic flow rates in terminal areas. One of the major considerations bearing on the achievement of increased traffic flow rates is the demonstrated hazard associated with the trailing vortex system caused by large aircraft. This hazard increases as the longitudinal separation between aircraft is reduced.

Various schemes have been proposed and are under investigation to reduce or eliminate this hazard. These schemes include vortex wake detection and avoidance systems, aircraft-mounted vortex dissipation systems, and ground-based dissipation systems. In support of FAA's wake turbulence program, there has been established at the National Aviation Facilities Experimental Center (NAFEC) a full-scale vortex measurement facility, described herein, which is capable of acquiring detailed information on the flow velocities in aircraft wakes. Analysis of this detailed information yields data on vortex movement, size, intensity, persistence and, to a lesser extent, structure, as a function of atmospheric conditions.

Concurrently with NAFEC's own test work, a requirement existed to support work directed toward the development of a vortex acoustic detection device. This support necessitated flying the test airplane past the test tower at a very close lateral distance, with the result that the majority of data is for relatively short vortex ages.

DISCUSSION

FLIGHT TEST PROGRAM.

TEST AIRPLANE. A Douglas DC-7 airplane was used for the flight test program. It is a large commercial four-engine propeller transport airplane powered by Curtiss-Wright R3350 turbo-compound reciprocating engines (Figures 1 and 2). It can be seen that the propeller thrust line is nearly coincident with the wing chord, which, under power-ON conditions, would distribute the propeller slipstream equally above and below the wing,

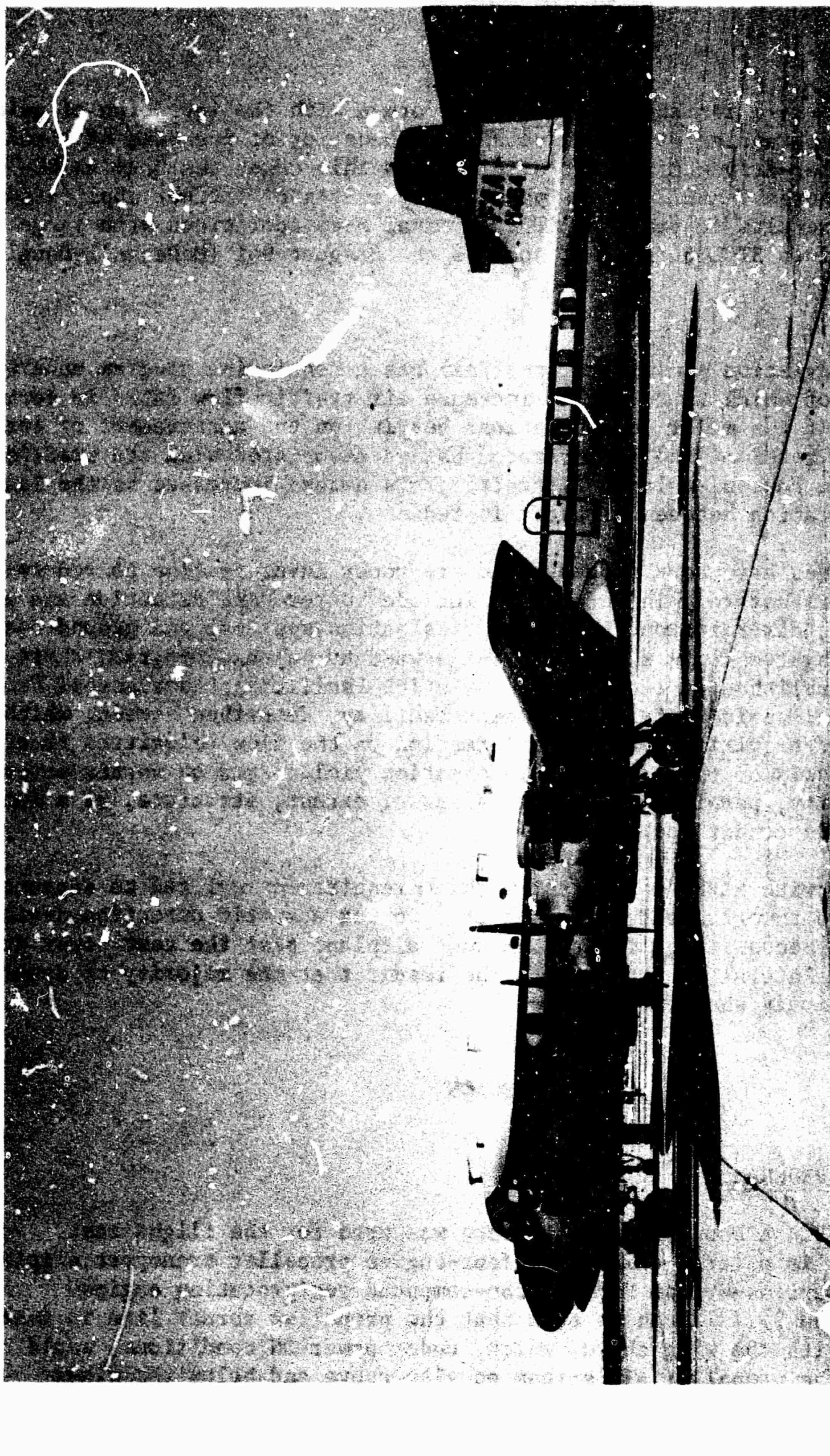


FIGURE 1. FEDERAL AVIATION ADMINISTRATION DC-7 TEST AIRPLANE.

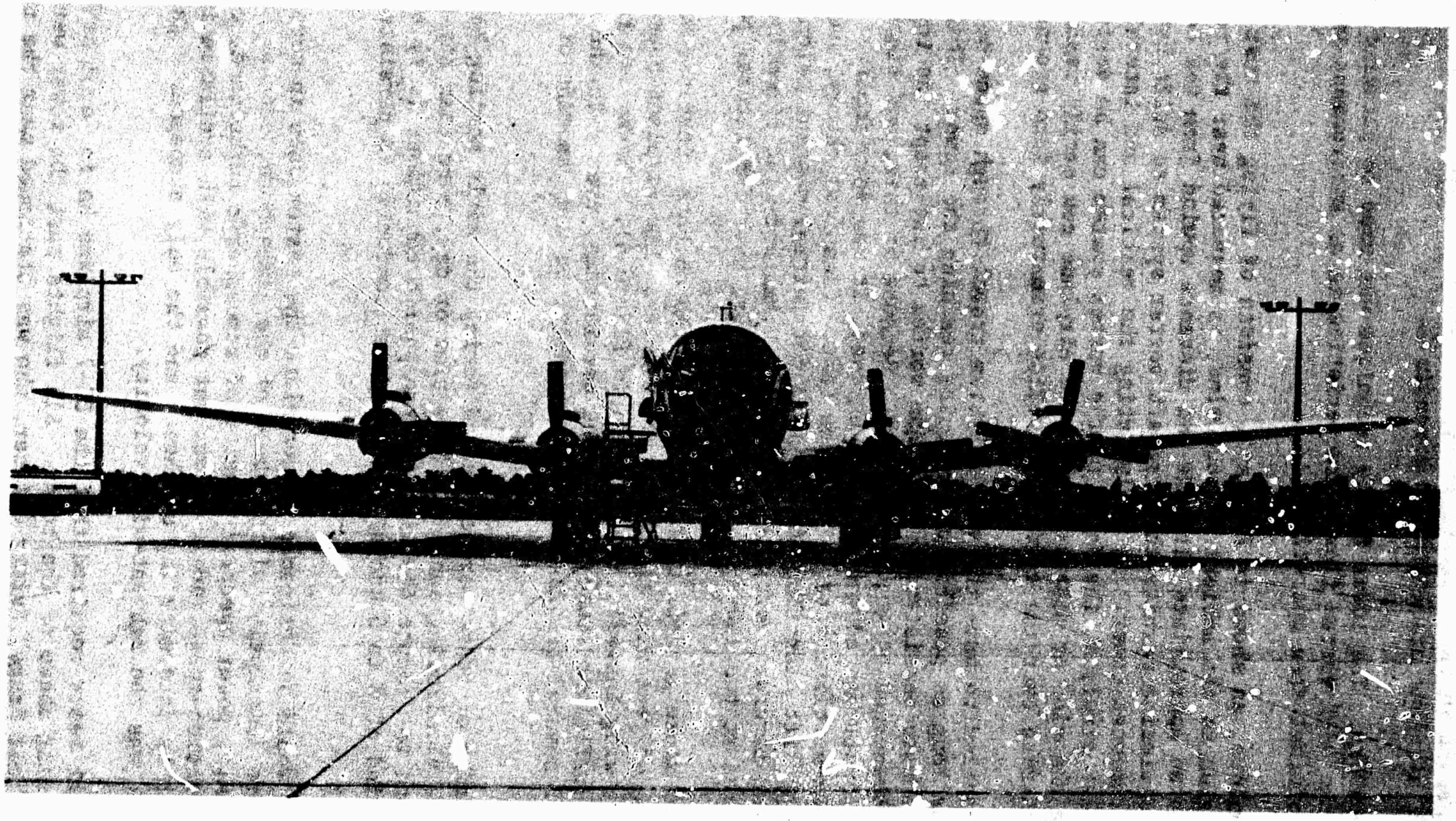


FIGURE 2. DC-7 AIRPLANE, FRONT VIEW, FLAPS UP.

adding energy into the wing vortex sheet. This condition is discussed further in this report in the analysis section. Further general specifications for the DC-7B airplane are listed in appendix A.

TEST PROCEDURE. The tower fly-by technique was used to gather quantitative data on the DC-7 vortex flow characteristics in an environment representative of the terminal area operation.

The technique, as shown in Figure 3, consists of flying the test aircraft at right angles to the ambient surface wind, as measured near the top of the tower, at an appropriate altitude and distance upwind from the tower. Proper space-positioning permits the aircraft vortex system to drift laterally into the instrumented tower. By manipulating the vertical and lateral position of the test airplane, the "age" of the vortex system can be varied. Miscalculating the wind or mispositioning the airplane can easily result in the vortex passing over the tower or settling prematurely into ground effect.

It was desired to have the vortex system travel through space out of ground effect as long as possible prior to its reaching the tower. This condition permits a more persistent and intense vortex to intercept the tower as compared to one attenuated by ground friction. Because of this, and since only a 140-foot instrumented tower was being used, it was very important to determine the vortex-settling rate before each test. Classical theory, using an assumed elliptical lift distribution, was used for initial descent calculations and associated aircraft vertical positioning. Ambient-wind direction and velocity, as measured at the 140-foot tower level, were used for lateral positioning.

A colored smoke grenade system was installed on both wingtips, with the intention of rendering the vortices visible as the airplane passed the tower (the port wing installation is shown in Figure 4). The system failed to provide sufficient smoke density and persistence, even with the simultaneous firing of several grenades, and accordingly, no use was made of it during these tests.

The majority of tests were conducted during the early morning hours immediately following sunrise. This time of day, more than any other, has been found to produce the kind of atmospheric conditions (very stable air mass, with a wind of 3 to 5 knots) that are most conducive to persistent, hazardous vortices.

While it would be desirable to correlate the vortex data in some manner with parameters descriptive of the state of the atmosphere, such as Richardson Number (R_i), power spectral density of atmospheric turbulence, or the ambient wind direction-speed index, it was not possible with available instrumentation to determine any of these, and the only atmospheric parameter available was the ambient-wind velocity.

The flight tests required that the DC-7 airplane be in level stabilized flight when passing abeam of the tower. All flights past the tower were controlled by the "Test Range" Safety Officer, who was stationed near the tower by the

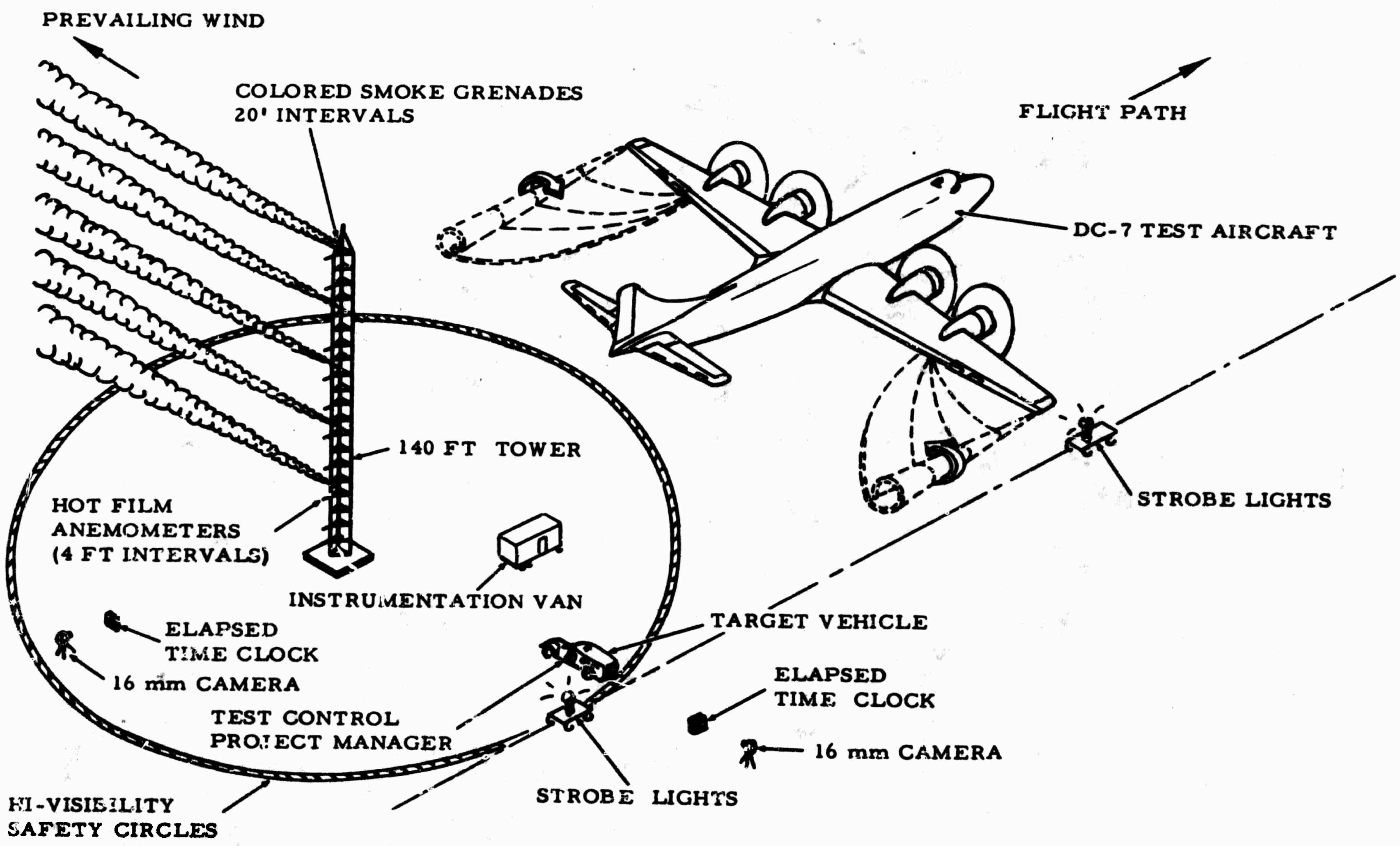


FIGURE 3. SCHEMATIC OF NAFEC TEST SITE - VORTEX MEASUREMENTS.

FIGURE 4. COLORED SMOKE GRENADE INSTALLATION ON DC-7, PORT WING.

ground-air radio command control vehicle. This vehicle, which had rotating beacons, was used in combination with strobe lights to facilitate aircraft alignment with the flight test track.

Phototheodolites were used to derive accurate space position information on the test airplane when it was abeam of the tower. For data reduction purposes, the reference point for the tracking stations was the nose of the airplane. The system has an overall accuracy of $\pm$ 5.0 feet at a range of 1,000 feet.

TEST TOWER. The test tower is 140 feet high with its base 76 feet above sea level. It is of equilateral triangle cross-section tapering from 5 feet on a side at its base to approximately 1 foot on a side at the top, using steel cantilever construction, requiring no guy wires. The tower, shown in Figure 5, is located 2,456 feet from the centerline of Runway 13-31 and 2,925 feet from the centerline of Runway 4-22. Details of the location are shown on Figures 6 and 7. The adjacent area is relatively flat, and covered with short grass.

INSTRUMENTATION.

AIRCRAFT. The test airplane carried no special instrumentation, none being required. A pilot log sheet was used to record the following information at the time the airplane was abreast of the tower:

1. Aircraft configuration.
2. Weight.
3. Airspeed.
4. Radar altitude above the ground.
5. Pressure altitude.
6. Track.
7. Lateral offset from tower.
8. Engine performance.
9. Atmospheric turbulence level noted by crew.

Phototheodolite data was used as the primary aircraft position information source, except where noted on the data sheets.

TOWER VORTEX MEASUREMENT. The 140-foot tower was instrumented with hot-film anemometers to measure vortex airflow. Vortex flow visualization was accomplished through the use of colored smoke grenades which were installed on racks at 20-foot intervals on the tower (see Figure 8). A further discussion of the instrumentation may be found in Appendix B.

Because of the signal degradation caused by the sound of the grenades burning, during those runs made for the purpose of testing and evaluating the XONICS acoustic vortex detection system, flow visualization by this means was not employed. An alternative visualization scheme, using streamers was tried (Figure 8), but these also caused too much acoustic interference, and their use was discontinued.

The airflow sensors record the total scalar magnitude of velocity components perpendicular to the hot-film element axis; i.e., the magnitude of the resultant

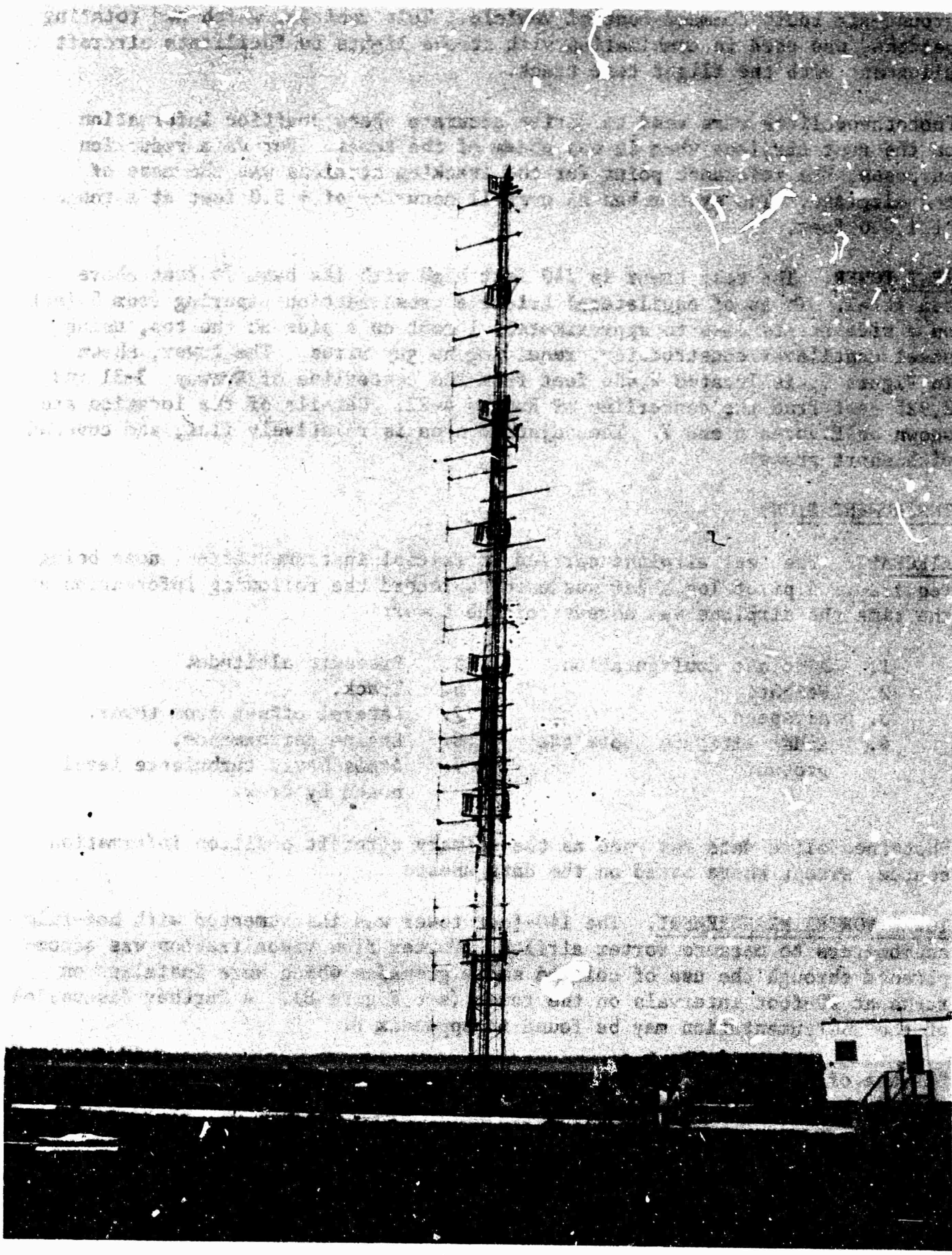


FIGURE 5. NAFEC VORTEX TEST TOWER.

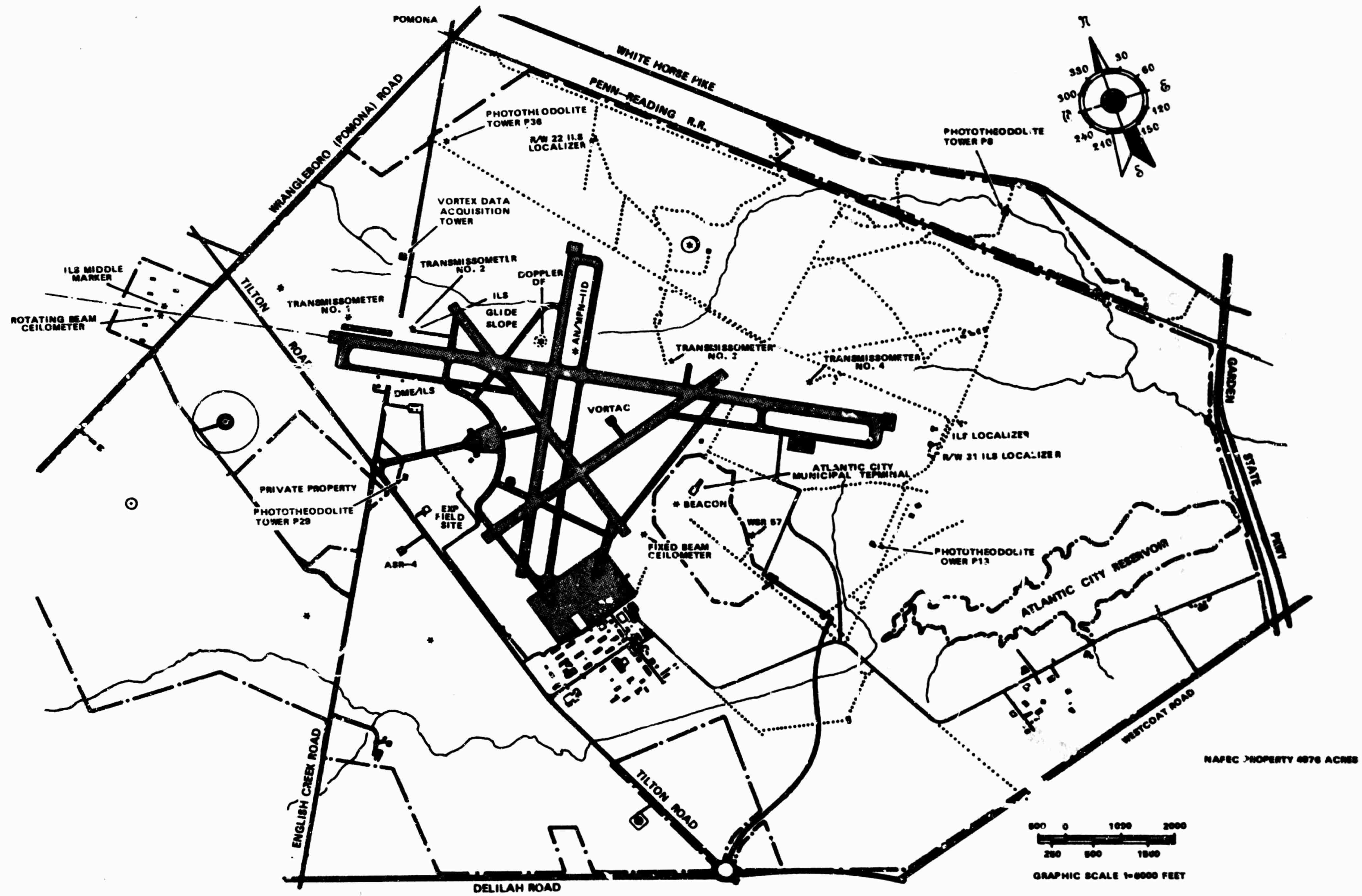


FIGURE 6. GENERAL LAYOUT OF NAFEC AIRFIELD AND THEODOLITE STATIONS.

NOT TO SCALE

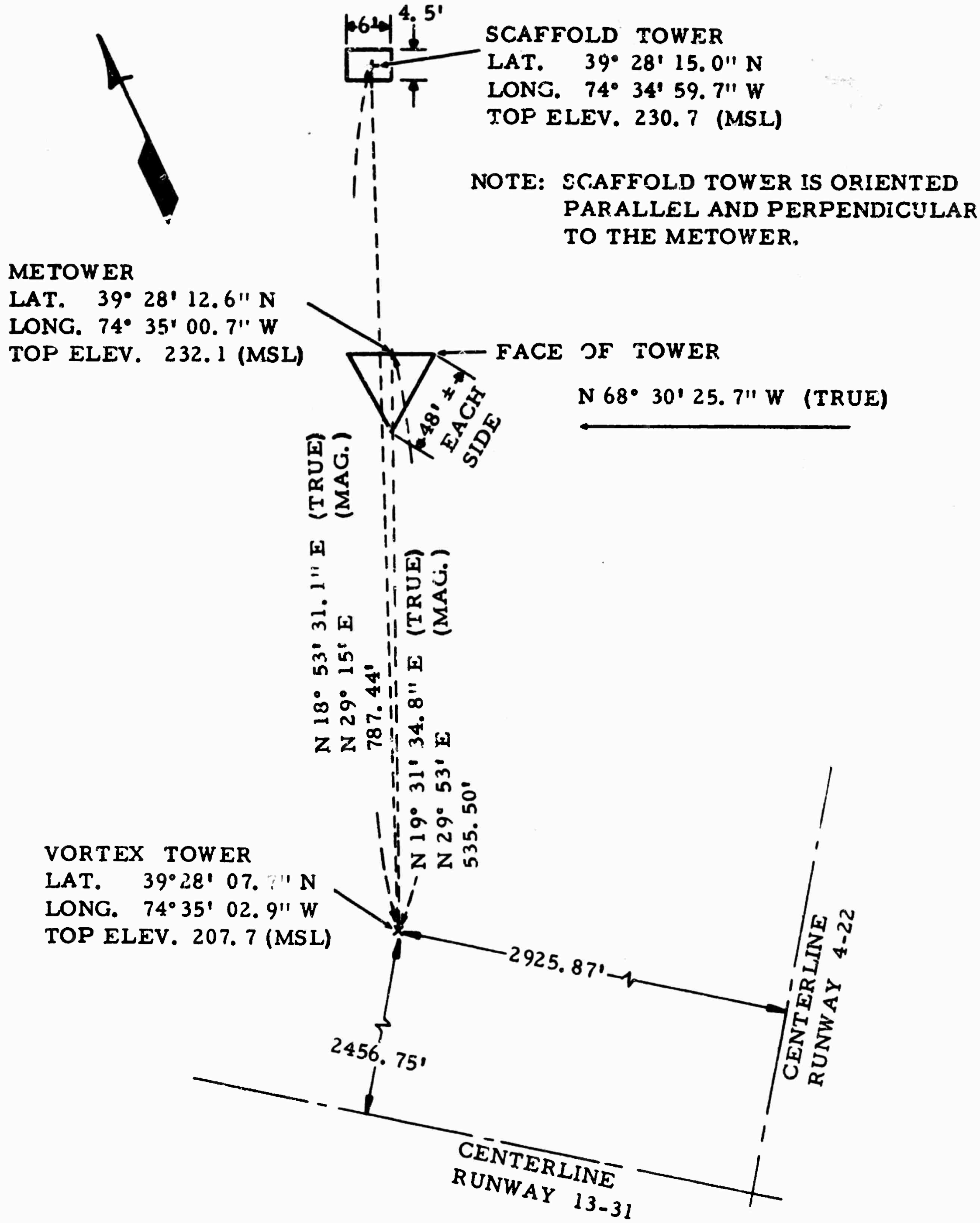


FIGURE 7. LOCATION OF VORTEX AND METEOROLOGICAL TOWERS.

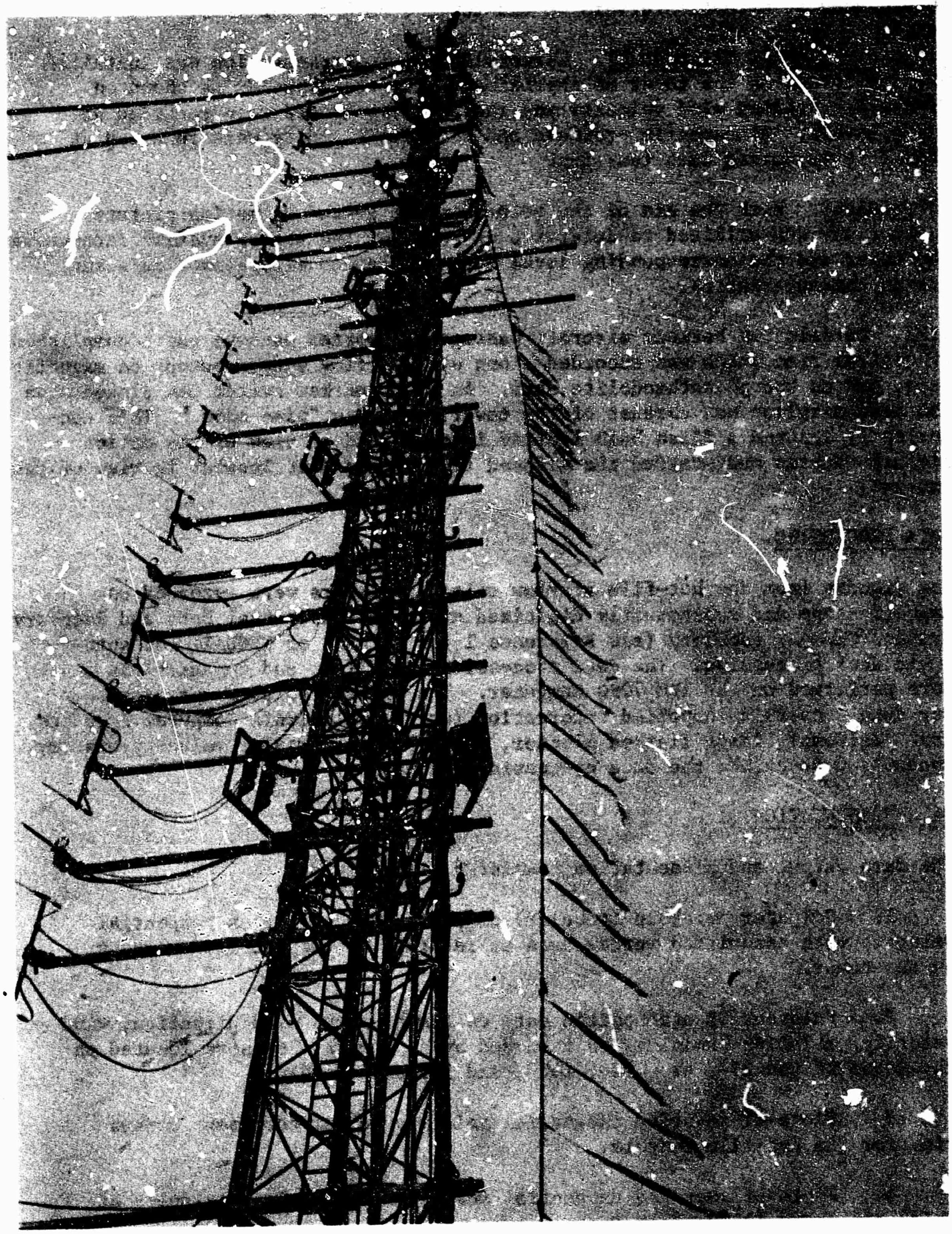


FIGURE 8. VIEW OF TOWER SHOWING AIRFLOW VELOCITY SENSORS, SMOKE GRENADE RACKS, AND STREAMERS.

vortex tangential velocities and the ambient wind flow velocities. The sensors were spaced at 4-foot intervals up the tower from 8 to 142 feet.

TOWER ATMOSPHERIC MEASUREMENT. Meteorological instrumentation was installed at five levels on the tower at approximately 25-foot spacing as shown on Figure 9. Ambient wind velocity and the air temperature were recorded at these levels. Atmospheric pressure and relative humidity were recorded at ground level during each test run.

PHOTOGRAPHY. With the aid of the colored smoke grenades, motion picture photography was utilized to determine if and when the vortex systems intercepted the tower and the corresponding level for correlation with sensor data and vortex characteristics.

TIME. Correlation between aircraft passage and vortex passage was accomplished by central time which was recorded along with airflow sensor output on magnetic tape, and on the phototheodolite data. An event marker switch was closed when the test airplane was abreast of the tower, denoting "time zero." This concurrently ignited a flash bulb located in the field of view of the motion picture cameras and started the elapsed time clocks also located in view of the cameras.

DATA PROCESSING.

The signals from the hot-film airflow velocity sensors were recorded on magnetic tape and subsequently digitized at the NAFEC Central Data and Recovery System (CENDAR) facility (see Reference 1 for details of CENDAR) for automatic data processing. The data processing, handling, and computations were performed on the IBM 7090 Computer. The special software programs for data conversion supplied information for the California Computer Products, Inc. (CalComp), large flatbed plotter, which produced sensor velocity history. Appendix C describes the data processing techniques.

DATA PRESENTATION.

The data output and presentation consisted primarily of:

1. Computer printout (tabular) of peak-recorded vortex tangential velocity with associated vortex ages as recorded by the hot-film sensors on the tower.

2. Printout of atmospheric data on temperature, wind direction, wind velocity, relative humidity, as recorded by appropriate sensors located on the tower at the 23-, 45-, 70-, 100-, and 140-foot levels.

3. Plots of recorded tangential velocity scalar component versus time for the hot-film sensors.

4. Plots of recorded tangential velocity versus time, examples of which are shown in Appendix D.

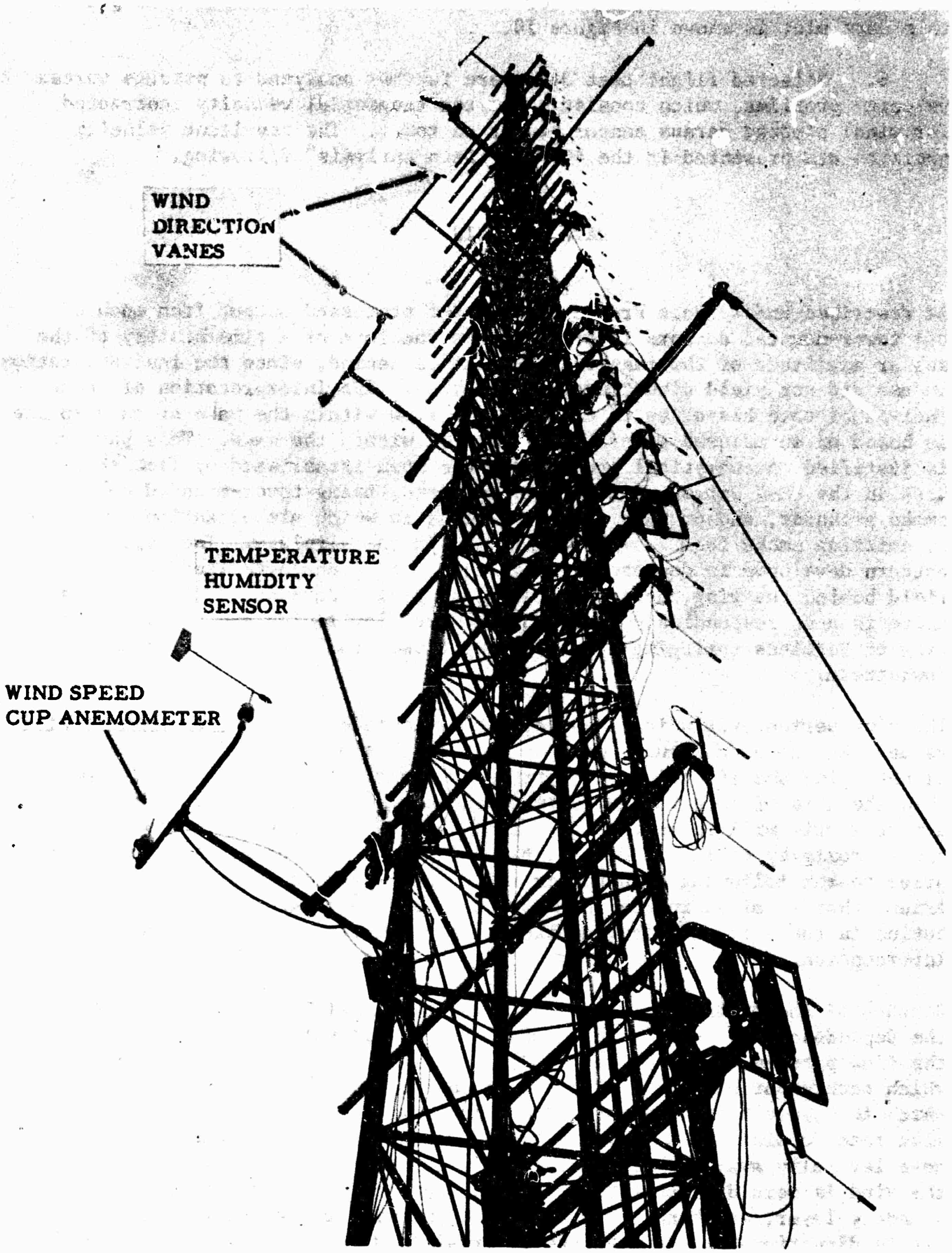


FIGURE 9. METEOROLOGICAL INSTRUMENTATION INSTALLED ON VORTEX TOWER.

5. Plots of recorded tangential velocity versus expanded time for better resolution when required for detailed vortex analysis. A sample of this data plot is shown in Figure 10.

6. Selected flight test data were further analyzed to produce vortex velocity profiles, which consist of vortex tangential velocity (corrected for wind) plotted versus sensor height on tower. The resultant velocity profiles are presented in the section "Data Analysis" following.

DATA ANALYSIS

As described under "Data Presentation," the processed output from each of the tower-mounted sensors is presented in the form of a time history of the scalar magnitude of the resultant velocities sensed, since the instrumentation in use did not yield directional information. The interpretation of these individual time histories to describe the flow within the wake of an airplane is based on an assumed general flow pattern within the wake. This pattern is justified on analytical grounds and has been established by flow studies, both in the DC-7 series of tower fly-by tests, using tower-mounted colored smoke grenades, and on many other occasions in which visualization was achieved by emitting smoke from a system installed in the airplane. The type of flow pattern developed is depicted in Figure 3. It is characterized by a downwash field behind the wing, across the complete span. Outside of the wing span, there is a corresponding upwash, and the two flow fields are coupled by a pair of vortices springing from the wing tips, trailing an indefinite distance downstream.

The time period over which measured flow velocities depart from ambient wind values may exceed a minute, but the bulk of this data can, for the time being, be set aside and attention concentrated on just two points in time; namely, when the axis of each vortex is instantaneously between sensors. In general, a vortex axis will be up to 2 feet from the nearest sensor, rather than in close proximity to it, because of the 4-foot spacing between sensors. Data prior to and following each vortex interception was considered only to the extent that it aided in the reconstruction of the tangential velocity distribution in the vertical plane defined by the sensors, at the instant of interception.

Because of the limitations imposed by the small height of the tower, and the dependence on a crosswind to cause the vortices to drift into the tower, the flow pattern in any of the subject vortices differs somewhat from that which occurs out of ground effect in a uniform wind field. Ground effect, which is apparent at a height of one wing span or less, causes the vortex sink rate to diminish and eventually become zero. At the same time the vortices move laterally away from each other. In ground effect, the influence of the wind is more difficult to predict because of wind shear in the earth's boundary layer, which not only causes height-wise variation in wind strength, but in direction too. A complete reversal in direction can occur between ground level and 200 feet. Any trailing vortex close to the ground then,

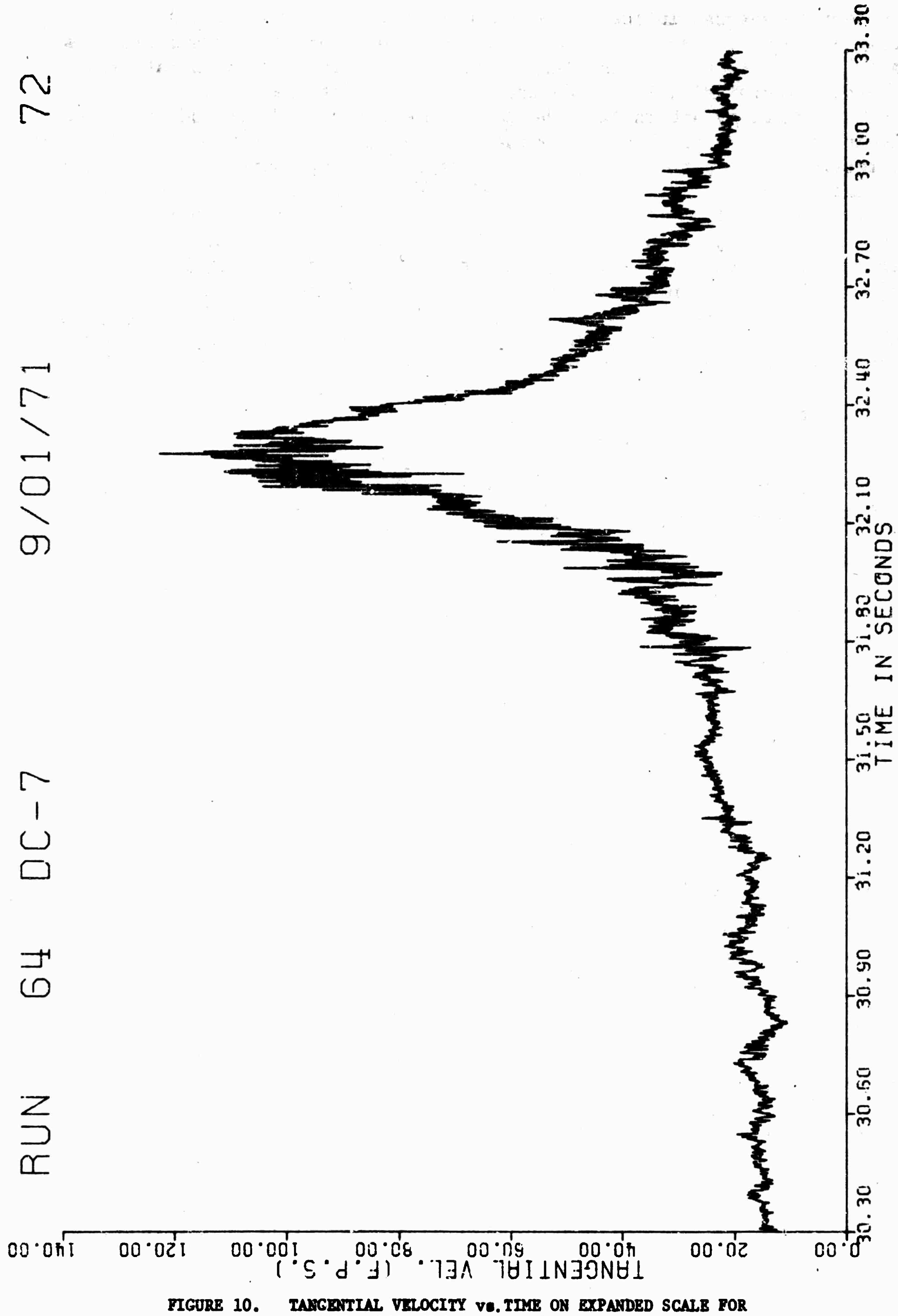


FIGURE 10. TANGENTIAL VELOCITY vs. TIME ON EXPANDED SCALE FOR ENHANCED RESOLUTION

is subject to several influences which distort the flow pattern, and it was determined to be impractical to attempt to account for all these influences, especially wind shear, for the large number of vortices on which data was recorded. Accordingly, it was decided to account for the wind, as far as the data permit, by subtracting the magnitude of the wind (or adding it where it is in opposition to the flow in the vortex) on the assumption of uniformity in direction. The wind strength was determined at each sensor level by taking the sensor output at time zero and/or after the vortex system had passed. There is adequate justification for leaving uncorrected the interference effects of the other member of the vortex pair and of the ground plane. These interference effects are always present and are indeed part of the overall problem. The situation is not analogous to the wind tunnel testing of models, where wall interference effects are an undesired and unavoidable by-product of the experimental technique and must be accounted for as fully as possible to make test results applicable to an actual flight situation.

The data reduction scheme used, then, reduces to identifying the first (downwind) and second (upwind) vortex and determining the age and height at which each strikes the tower. The possibility does exist for some airplane configurations, of there being more than the usual pair of counter-rotating vortices in the wake, due, for example, to rapid changes in the local lift distribution associated with the end of a fully deflected flap, but this is only true for short time intervals after generation, and anything but a rolled up vortex pair is unstable and very rapidly develops into a normal vortex pair. At the instant when there is a vortex core in close proximity to one of the sensors, the tangential velocity distribution up the tower is determined. The rotation is such that the tangential velocity in the lower part of the first (downwind) vortex and the upper part of the second (upwind) one is additive to the wind, and is in opposition to the wind in the upper part of the first vortex and in the lower part of the second. For the latter situation, a problem arises in interpreting the data. A resultant velocity vector of 10 feet per second (ft/s) may be the result of a 20-ft/s wind opposing either a 10- or a 30-ft/s tangential velocity. Only with three-dimensional anemometry, capable of resolving all directional ambiguities, can this type of ambiguity be resolved. It frequently happens that neither value appears to fit the expected tangential velocity distribution. This is due to the fact that in any part of either vortex, where the local tangential velocity is in opposition to the wind, it is inevitably subject to interference effects from the tower and/or sensor-mounting arms.

A typical set of velocity-time-history data is presented in Appendix D. Figure 10 is a time history drawn on an expanded time scale for enhanced resolution. The complete set of tangential velocity distribution plots is presented in Appendix E. Typically they show a tight, rapidly rotating core with a rapid fall in tangential velocity beyond the core. The plots may be used in directly determining the upset moment experienced by an airplane encountering a vortex, bearing in mind (1) that the peak velocity apparent in the plot is usually not the maximum that actually was generated by the vortex, on account of the wide (4-foot) spacing between sensors, and (2) that the interpretation of the velocity-time-history plots to arrive at the

velocity distribution is a rather subjective matter at present, especially from the core center outwards into that half of the vortex where the induced velocity is in opposition to the wind.

In all discussion of vortex motions and locations, it is assumed that the airplane's track over the ground is situated on the windward side of the tower. With this in mind, the first (downwind) vortex is the closer one to the tower. The terms port and starboard appear at some points in the text - they have the usual meaning and do not indicate first or second, upwind or downwind. They do have significance when discussing vortices of conventional propeller-driven airplanes, however, since, with the normal rotation (right-handed when viewed from behind on all engines) of propellers, those on the port wing rotate with the corresponding tip vortices, while those on the starboard wing rotate against the tip vortices.

Having determined the horizontal velocity profiles (Appendix E) of the vortices (and owing to mutual interference, wind and ground effect, these will not be the same as the vertical velocity profiles), a simple analysis of the results can be made. Optical tracking by the NAFEC theodolite towers accurately (±5 feet) pinpoints the position of the subject airplane as a function of time. Time "zero" is defined as the time when the subject airplane is abreast of the tower, and the time for a vortex generated at time "zero" to reach the tower may be determined. At the same time, the vertical distance travelled by each vortex can be measured. Horizontal and vertical transport velocities can then be determined.

The data presented in this report apply to the DC-7 airplane (Figures 1 and 2), which was flown in the following configurations:

Takeoff
Holding
Landing
} Power settings in each case were those required for level flight at 120 - 130 knots.

Figure 11 shows peak-recorded velocity as a function of vortex age for the entire set of runs and several deductions may be made from this plot. It illustrates the fact that at any given point along the abscissa, considerable variation in the data occurs, primarily because of the wide (4-foot) spacing between sensors. In general, the true peak tangential velocity in a vortex will not be encountered by the sensor, since distance between the vortex axis and the nearest sensor varies randomly from run-to-run, between limits of ±2.0 ft. If a very tight vortex core is formed, the tangential velocity distribution falls off sharply from either side of the peak, and among a large number of values of peak-recorded velocity, a high percentage would fall in the middle to lower part of the possible range of values. This is the case with the data in Figure 11 and any typical set of time-history plots likewise indicates the existence of a very tight core. At each vortex interception, local velocities peak and fall off again very rapidly. At any vortex "age" between 10 and 30 seconds (insufficient data exists outside of

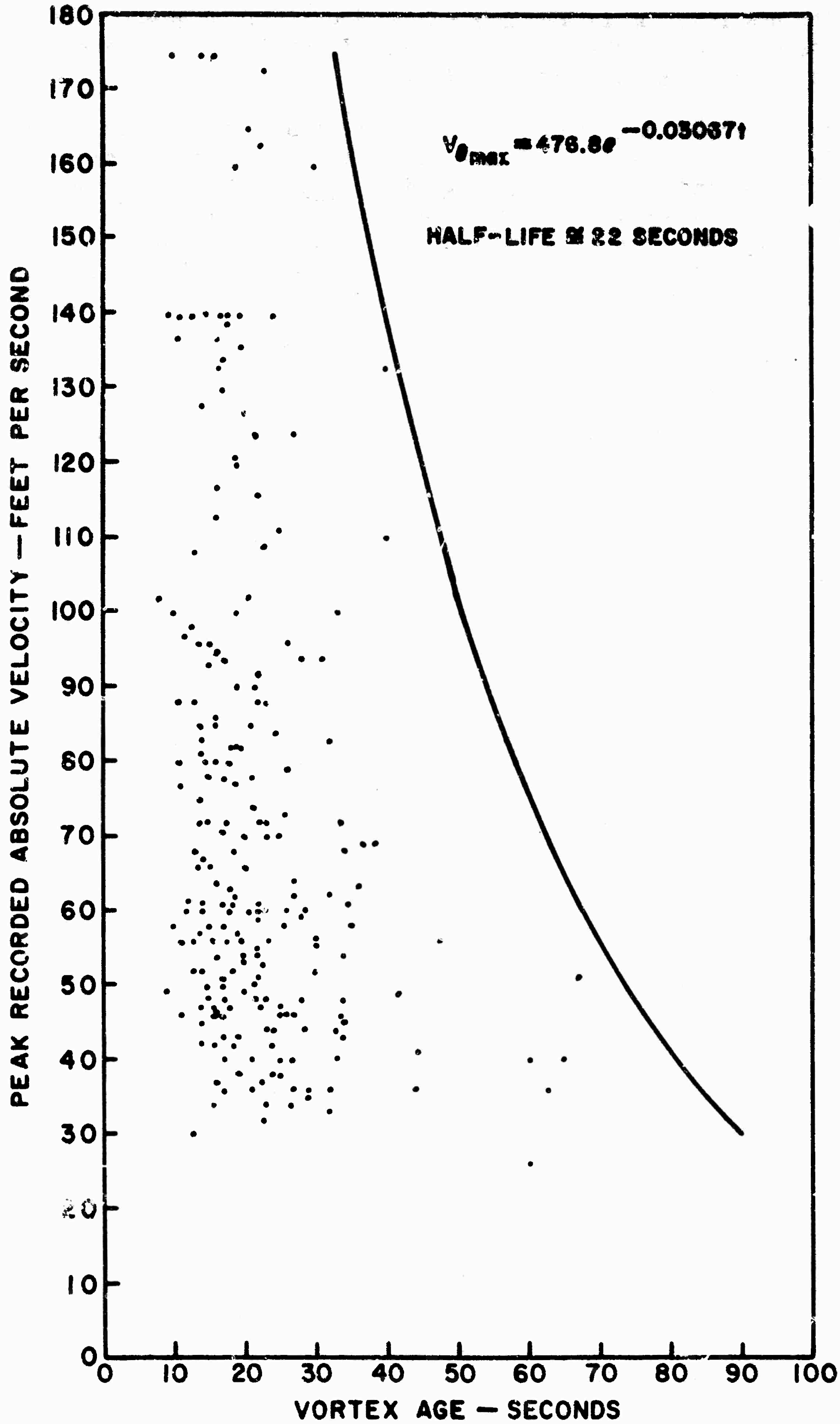


FIGURE 11. PEAK RECORDED ABSOLUTE VELOCITY vs. AGE - ALL DATA POINTS.

this range to draw any conclusions), the majority of data points fall between 100 and 30 ft/s, with only a small number reaching the maximum value. This is consistent with the existence of a very small diameter core.

Figures 12 and 13 present data derived from the peak-recorded velocities. Figure 12 shows the peak-corrected velocity (wind subtracted), and it is noted that there is little or no change. In Figure 13, the peak-corrected velocities were normalized by dividing by ($1/2\ C_L\ V$) in order to account for the effect of weight and airspeed.

Figures 11 through 13 are of interest in that they appear to establish an upper boundary of peak tangential velocity as a function of time. The boundary can be represented by the function $V_{\theta\ max} = 476.8 \exp(-.03067t)$, with half-life of 22 seconds. This is not a rigorous index of the severity and upset potential of a vortex, because the velocity distribution of either side of the peak is what really determines the moment generated on a following airplane making an encounter with the vortex. It is nevertheless, useful to know how the angular momentum of the core is diffused radially as a function of time, and for a given (generating) airplane, in a given flight condition and configuration, the peak velocity is an index of how far diffusion has progressed, assuming constant circulation at the core radius. The graphs in Appendix F present peak-recorded velocity as a function of time (vortex age) and ambient wind velocity.

In the graphs on pages F-1 through F-6, the peak-recorded absolute velocities are presented according to airplane configuration and whether it is the upwind or downwind vortex. The significance of the distinction is simply that the effect of the wind is not the same on each vortex. In the absence of wind, the vortices, on entering ground effect, move symmetrically, horizontally away from each other, counter to the direction a solid disc would move having the same direction of rotation. Referring to Figure 3, the wind adds to the lateral velocity of the first vortex and subtracts from that of the second. However, if wind shear is such that velocity increases progressively with altitude (linearly, parabolically, or logarithmically for example) with no change in direction, any velocity profile would tend to strengthen the second vortex and conversely, weaken the first. From the foregoing considerations, it seems possible that quite large differences could develop between first and second vortices. As it turns out, comparing graphs on page F-1 with F-2, F-3 with F-4, and F-5 with F-6, the idea of the second vortex being the stronger (age for age) does not appear to be supported. If anything, judging from present data, the reverse may be true.

Comparing the data on the basis of airplane configuration, the highest peak velocities occurred in the landing configuration, while the lowest values are generated in takeoff configuration (with a marked fall off in peak velocity for upwind vortices). In holding configuration, for the relatively small number of data points, peak velocities may be as high as for landing configuration.

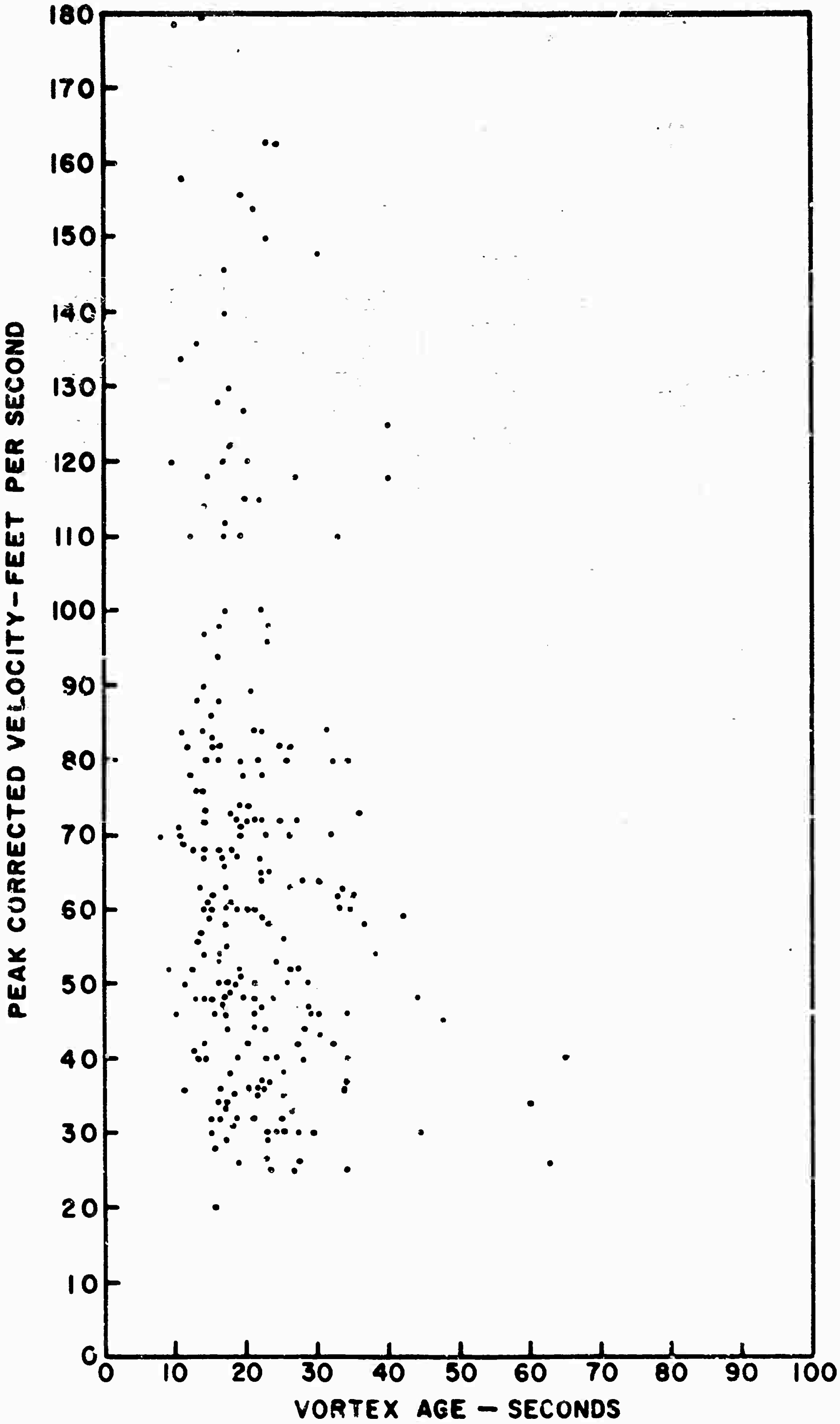


FIGURE 12. PEAK CORRECTED VELOCITY vs. AGE - ALL DATA POINTS.

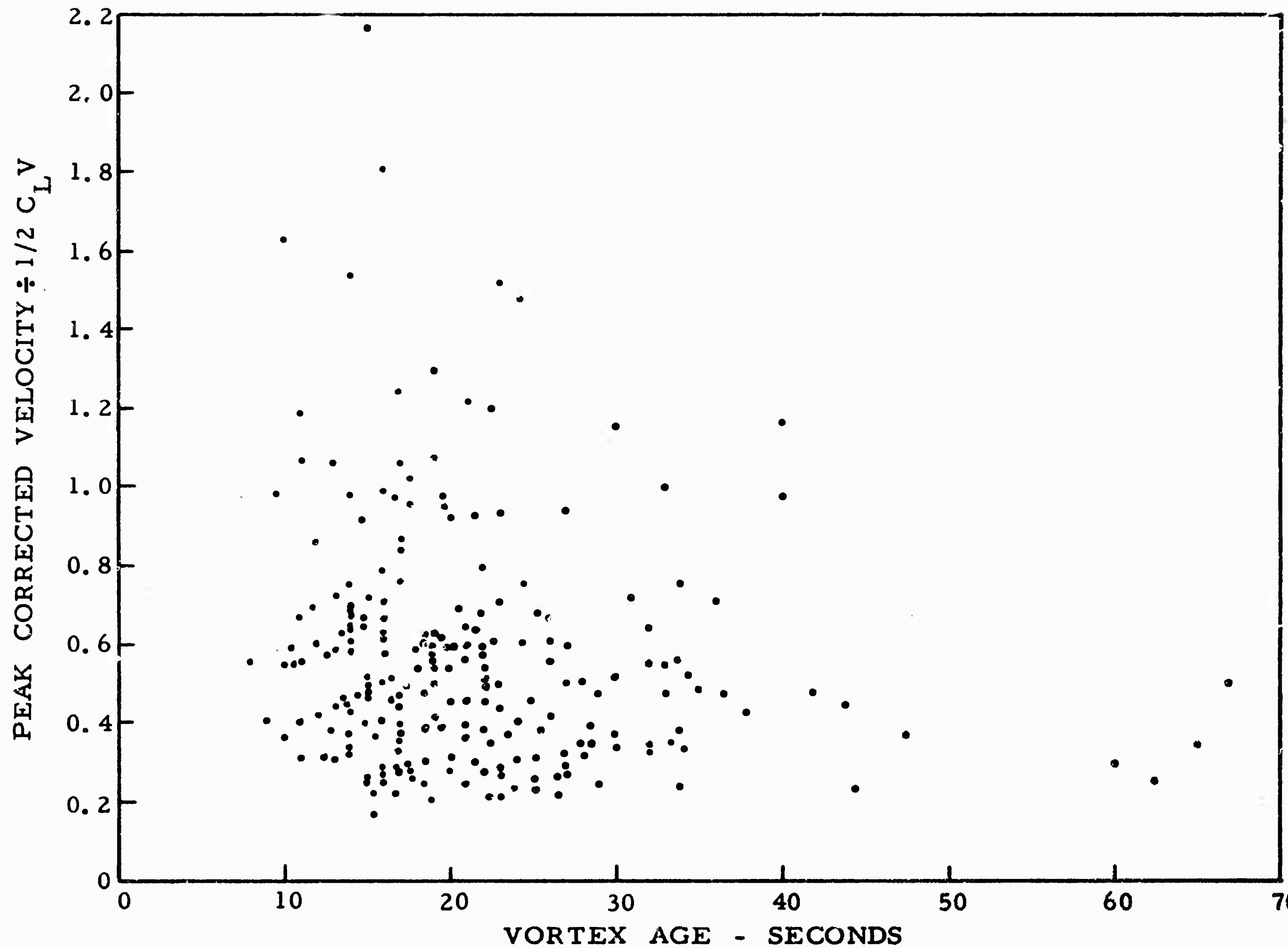


FIGURE 13. NORMALIZED VELOCITY vs. AGE - ALL DATA POINTS.

In the case of conventional, propeller-driven airplanes, the propellers all turn one way (clockwise viewed from behind), and the influence of slipstream rotation on the adjacent tip vortex is possibly significant, especially on large airplanes in flight configurations employing large flap deflections. A rapid change in the local circulation occurs at the end of the flap, and the thrust line of the outboard engines of conventional four-engined, propeller-driven airplanes is near the same spanwise station, where slipstream would be most expected to augment or counter the large amount of shed vorticity associated with that rapid change in local circulation. In the present series of tests, most runs were made with the port wing closest to the tower. A few runs were made with the airplane's starboard wingtip closest to the tower.

These runs have been categorized according to configuration and propeller rotation and the data presented in Appendix F, pages F-23, F-24, F-27 and F-28 for the takeoff and landing configurations. In holding configuration, the total number of data points is small, and it is doubtful if a valid comparison can be made - however, the data has been extracted and is presented in Appendix F, pages F-25 and F-26. The greatest effect due to slipstream rotation would be expected to show up in the takeoff configuration and the least in landing. For holding configuration with zero flap setting and an intermediate power setting, the slipstream rotation effect would fall between the maximum and minimum represented by takeoff and landing. In point of fact, the flight configuration that has been consistently referred to as "landing" in this and all tower fly-by test documentation differs somewhat from the true landing configuration since the power setting was sufficient to maintain level flight at equivalent airspeeds between 120 and 130 knots. Likewise, while the term "takeoff configuration" indicates gear down and flaps in the takeoff position, the power settings employed were again appropriate to level flight at indicated airspeeds between 120 and 130 knots and were at all times consistently lower than those employed in the so-called "landing configuration." Bearing in mind the above, and the fact that all the data runs, regardless of airplane configuration, were flown at airspeeds between 120 and 130 knots Indicated Airspeed (IAS), in level flight at 200 feet altitude or less, the holding configuration would require the least power (flaps and gear, both up), and the landing configuration (flaps 50°, gear down) would require the most power. In terms of Brake Mean Effective Pressure (BMEP) and fuel flow rates, this is confirmed in the experimental record (Summary Flight Test Data Sheets Appendix G). This being the case, it would be expected that the greatest slipstream rotation effect, if it is significant at all, would occur in the landing configuration. Referring now to Appendix F, pages F-23 through F-28, a marked difference appears in takeoff configuration, a difference which definitely appears to indicate higher peak velocities in vortices augmented by slipstream. In holding configuration, as already remarked, it is doubtful whether any determination can be made. In landing configuration, there is an unexplained absence of any trend.

Appendix F, pages F-7 through F-16 were plotted in order to determine if correlation existed between peak-recorded velocity and ambient windspeed. The effect of the wind has been discussed earlier, with an indication of possible effects on vortex structure. Another effect to be considered is atmospheric

turbulence. The only available index of turbulence for this report is the wind velocity; if increasing wind velocity results in greater atmospheric turbulence, then one result of this would be a more rapid disintegration of the organized flow pattern in the vortex, with a reduced peak velocity. To eliminate two variables from consideration in each plot, the data was categorized according to "age" group and whether it related to the upwind or downwind vortex, the significance of which distinction has already been discussed.

The results of this categorization are not very conclusive, however in Appendix F, pages F-7, F-8 and F-14 (and to a lesser extent pages F-9, F-10 and F-11) the graphs appear to exhibit the expected trend. An alternative scheme of grouping which should produce supporting evidence is to group by wind velocity and vortex type (i.e., upwind or downwind) and plot the results as a function of vortex age. The results are presented in pages F-17 through F-22 and again, the result is inconclusive, but does appear to exhibit a trend of decreasing peak velocity with increasing windspeed.

Accurate measurement of the airplane's position in space relative to the tower was made using the NAFEC Phototheodolite Range. This provides, as a function of time, the horizontal and vertical position, track over the ground, and absolute groundspeed. Using the available wind data, which in this series of tests was limited (wind strength and direction were measured at one height only, 100 feet), an estimate of the crosswind velocity component was made, and it has thus been possible to correlate vortex lateral transport velocities with the magnitude of the crosswind velocity component. The theodolite data locates the nose of the airplane, and it was assumed that the lateral spacing of the vortices, except at the instant of generation, was less than the airplane's geometric span, by a factor of $\pi/4$. It is thus a simple matter to determine how far each vortex has had to travel between time "zero" and time when it hits the tower. To the extent that the crosswind as determined is rarely an exact crosswind, and that the wind close to the ground is variable in intensity and direction, as a function of altitude and usually time as well, it is impossible to be very precise in determining the wind velocity that should be correlated with the measured lateral transport velocity of the vortices as a whole. Appendix H discusses this small error, introduced by the deviation of the wind from the true crosswind direction.

Potential flow theory gives the descent velocity of a vortex pair, and the lateral velocity that develops as such a pair enters ground effect. The solution can be obtained for zero wind or for any wind whose velocity profile in the area of interest can be described by a potential function. A detailed solution has been worked out for the zero wind case, and two of the more important results are presented. The lateral and vertical velocities are as follows:

$$\dot{y} = \pm \frac{\Gamma s^2}{4\pi z^3} \quad ; \quad \dot{z} = \frac{-\Gamma}{4\pi s} \; \frac{(z^2 - s^2)^{3/2}}{z^3} \quad , \qquad (1)$$

($\dot{y}$ positive for starboard vortex, negative for port)

Where y and z are defined in the sketch following, with their origin at the centroid of the system. In the limit, as time approaches infinity, z approaches s (s = half the initial lateral distance between vortices, out of ground effect), and we have

$$\dot{y} = \frac{\Gamma}{4\pi s} \quad ; \quad \dot{z} = o \quad , \tag{2}$$

while initially, out of ground effect, z is very large, and we have

$$\dot{y} = o \quad ; \quad \dot{z} = \frac{-\Gamma}{4\pi s} \tag{3}$$

The time for a vortex pair to descend the vertical distance between two points

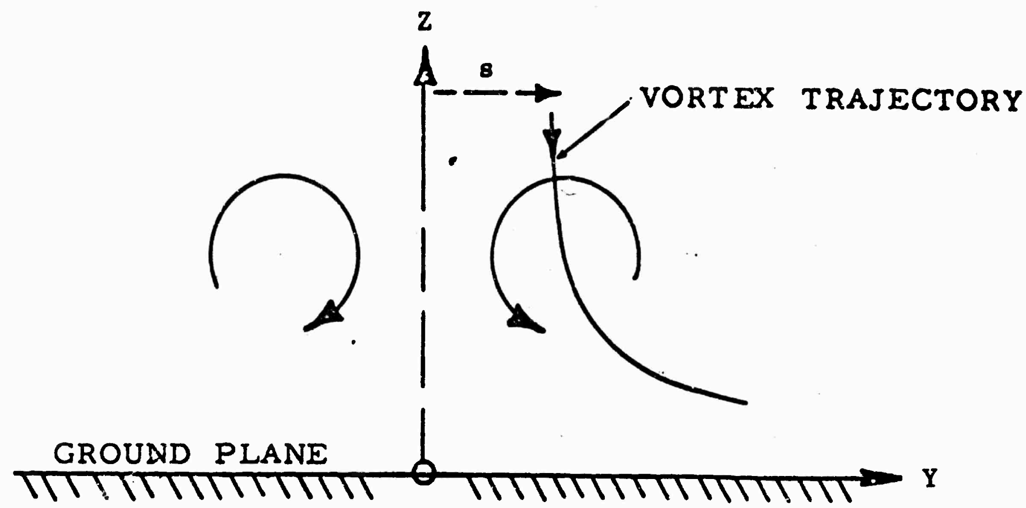
z_1 and z_2 is given by

$$T = \frac{8\pi s^2}{\Gamma} \; \text{Cot } 2\phi \Big|_{\phi_1}^{\phi_2} \tag{4}$$

where ϕ_1 = Arcsec z_1/s

ϕ_2 = Arcsec z_1/s

Γ = Median Circulation, ft^2/sec.



Evaluating this for a typical DC-7 run, to which the following data apply:

Run No.	61
Gross Weight	92,000 pounds
EAS	126 knots
Lift Coefficient C_L	1.168
Configuration	Takeoff
Median Circulation	2,390 ft^2/sec (Schrenk's Method (Ref. 2))
Wing Span	117.5 ft
s	46 ft
Aircraft height abreast of the tower	127 ft
Vortex height at tower	58 ft
Vortex age	22 seconds

Using Equation (4) to compute the time for the vortex to descend from 127 to 58 feet, we obtain: T =30.3 seconds.

Equation (4) can easily be transposed to yield the horizontal transport times in ground effect. Appendix F, pages F-29 through F-34 show the experimental mean vortex descent rates as a function of airplane height abreast of the instrumented tower, categorized by airplane configuration, upwind or downwind vortex (the latter categorization was unnecessary except to avoid crowding of data points), and the plots show the expected result that the descent rate is higher for the higher altitudes in which ground effect is initially weaker. The very large amount of scatter stems from the fact that descent rate is a function of many more variables than the obvious ones of circulation, wing span and initial altitude. The problem is complicated by a marked tendency of the vortices to loop and "snake" about, plus their (as yet undetermined) sensitivity to the temperature lapse rate, thermal activity (which is not restricted to just warm weather), and buoyancy effects. For the example quoted here, the vortex appeared to travel a vertical distance of 69 feet in a time interval of 22 seconds, for an average descent rate of 3 ft/s, with initial altitude of 127 feet. At the other end of the scale, the following data apply to Run 142:

Gross weight	92,600 pounds
EAS	125 knots
Lift Coefficient C_L	1.194
Configuration	Takeoff
Median circulation	2,420 $feet^2$/second
Aircraft height abreast of the tower	205 feet
Vortex height at tower	83 feet
Vortex age	21.5 seconds

Equation (4) yields an elapsed time of 28.9 seconds to descend the 122 feet between time zero and striking the tower for an average descent rate of 4.2 ft/s.

The theoretical mean descent rates have been determined for every run, based on a median circulation calculated by Schrenk's approximation. The calculation assumes that at time zero, ground effect is negligible and that the lateral spacing between vortices very rapidly reduces to π b /4. The correlation with the measured mean descent rates is shown for the three test configurations in Figure 14. The scatter is very great, due to a number of causes, principally "snaking" of the vortex which can obviously cause the mean descent rate of a segment of the vortex to differ, over a limited time interval, from the mean descent rate of the system as a whole. Though the data are scattered, however, the central values correlate quite well with the theoretical values.

Vortex lateral transport velocities as a function of crosswind velocity component are presented in Appendix I, pages I-1 through I-7. The data is fairly scattered and a least squares fit has been applied. Out of ground effect, in a uniform crosswind, the lateral drift rate is simply equal to the magnitude of the crosswind. In ground effect, due to momentum loss in the boundary layer, correspondence between drift rate and crosswind is not one-to-one since the wind plotted here is that measured at 100 feet above ground level and does not necessarily represent a mean taken over the height range of interest. The slope of the line yielded by the least squares fit, relating lateral transport velocity to crosswind velocity component, falls between 82 and 96 percent for the takeoff and landing configurations. The data is very sparse for the holding configuration and the slopes obtained should not be regarded as typical, especially since no data points were obtained at the higher crosswind velocities. There is nothing so far unusual about the results - the drift rate bears a plausible relationship to the crosswind velocity, both as to slope and linearity, and data pertaining to downwind vortices (Appendix I, pages I-1, I-3 and I-5) intercepts the vertical axis at a consistent 5-6 ft/s, compared with 4 ft/s yielded by potential flow theory. An apparent anomaly arises, however, in the upwind vortex data, which should yield a "zero wind" lateral transport velocity opposite in sign to that obtained from the downwind vortex data, but does not do so.

A final series of plots is presented in Appendix I, pages I-7 through I-12, in which peak-recorded velocity, grouped by "age," has been plotted as a function of airplane height at time zero, the intent here being to show the effect of close proximity to the ground in absorbing the rotational energy of the vortex. This is certainly known to happen and has been amply demonstrated in flow visualization studies, but does not show up at all convincingly in the plots presented here. This could be for two reasons, the large scatter in peak-recorded velocities arising from the 4-foot sensor spacing obscures the picture, and there is insufficient spread between the maximum and minimum airplane altitude abreast of the tower.

Figures 15 through 22 are a representative selection of flow visualization photographs that clearly demonstrate the circular nature of the flow, the downwash field between vortices and the tightness of the vortex cores.

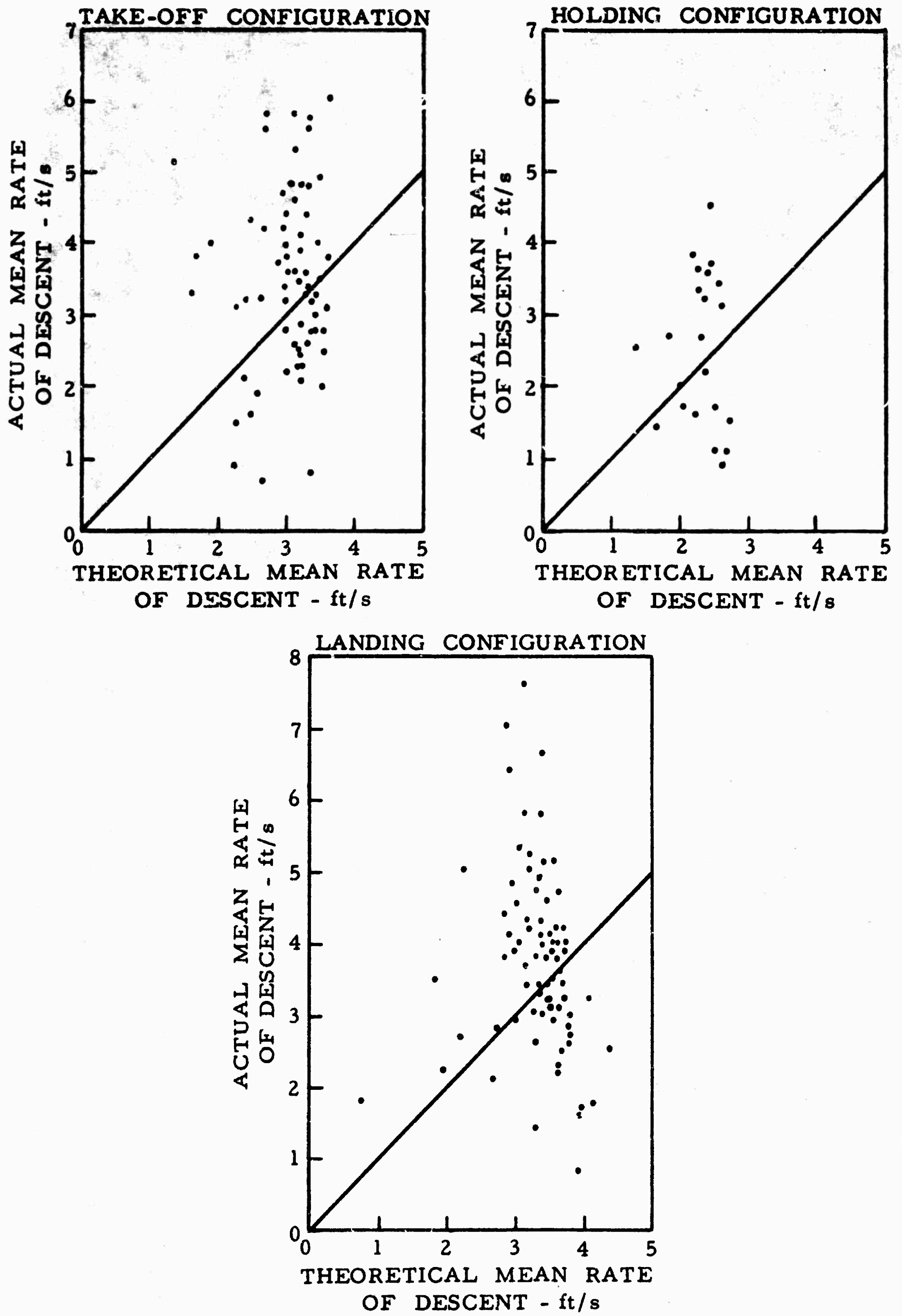


FIGURE 14. COMPARISON OF THEORETICAL AND ACTUAL VORTEX MEAN DESCENT RATES.

FIGURE 15. DC-7 AIRPLANE VORTEX PAIR.

FIGURE 16. DC-7 AIRPLANE VORTEX TUBE.

"RE 17. DC-7 AIRPLANE VORTEX TUBE, INDICATING BIAXIAL FLOW OF VORTEX ENTRAINED SMOKE.

FIGURE 18. DC-7 AIRPLANE VORTEX TUBE, OBLIQUE VIEW, NOTE APPARENT CONCENTRIC FLOW CYLINDERS.

FIGURE 19. DC-7 AIRPLANE VORTEX (2 MIN - UPWIND) PASSING TEST TOWER LEFT TO RIGHT. NOTE LAMINAR-TYPE FLOW AND "DOWNWASH" FIELD TO RIGHT OF VORTEX.

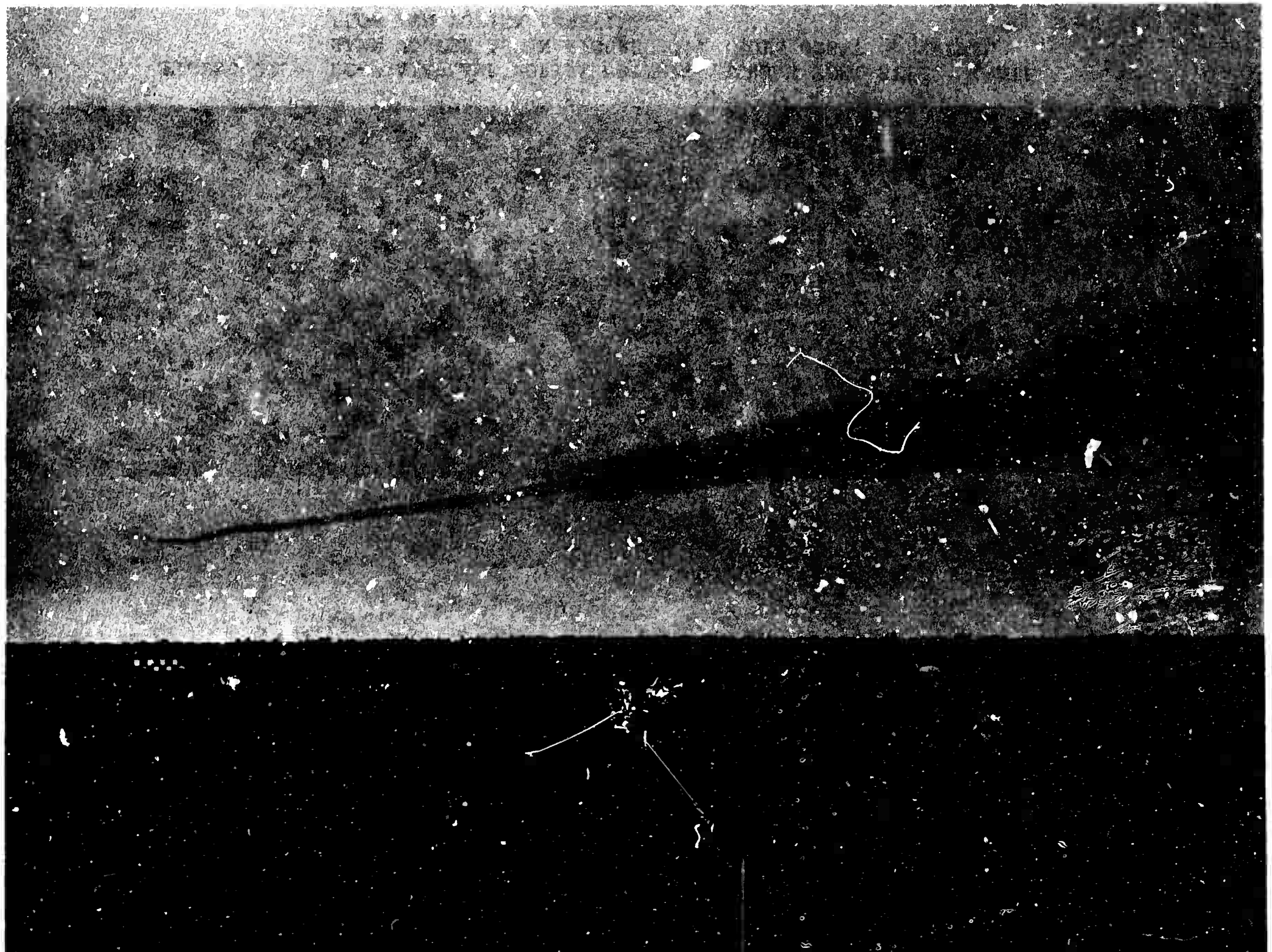


FIGURE 20. DC-7 AIRPLANE VORTEX DRIFTING ACROSS TEST SITE. NO SELF-INDUCED OR ATMOSPHERIC-INDUCED BREAKUP NOTED. DISTURBANCE TO RIGHT CAUSED BY TOWER PASSAGE.

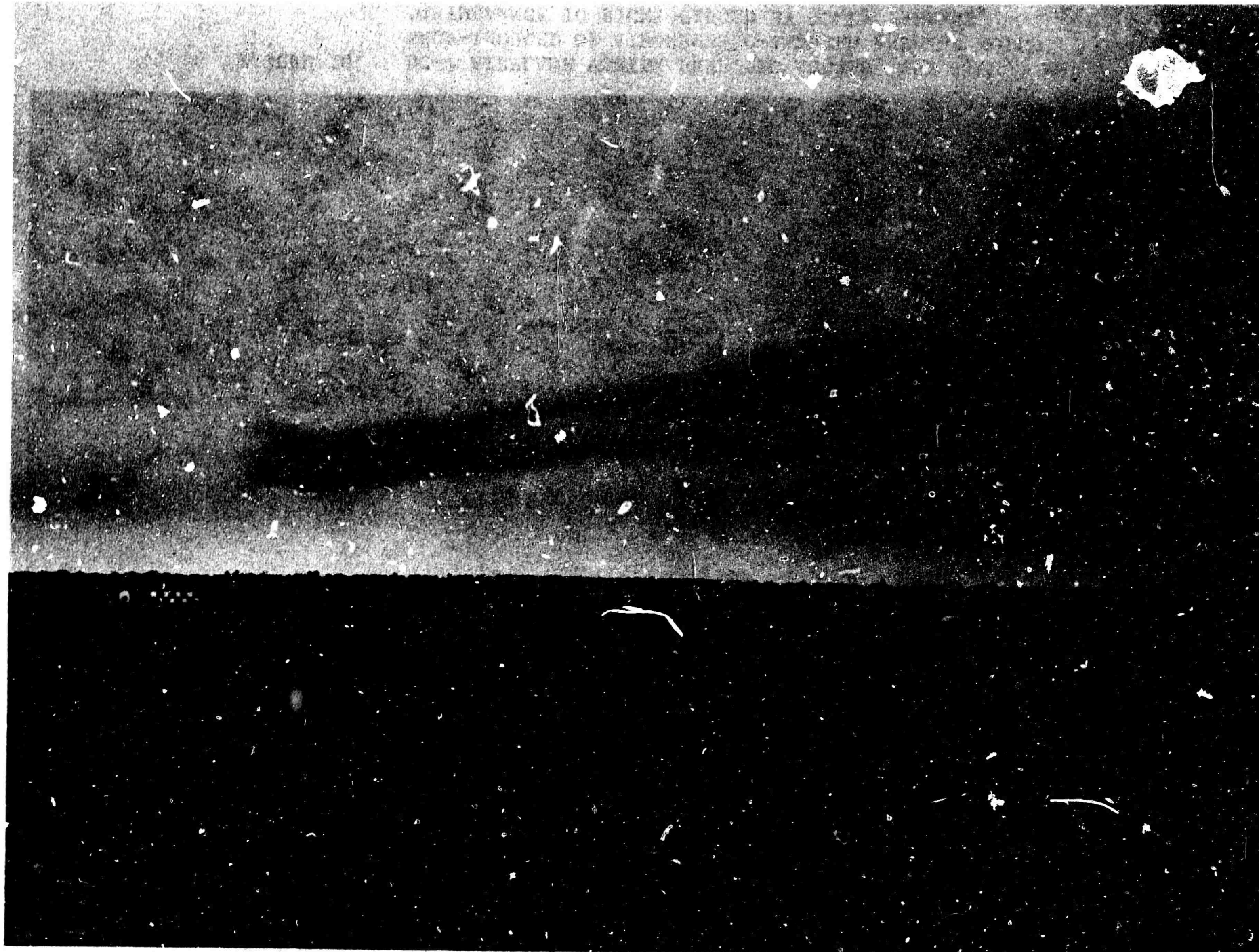


FIGURE 21. DC-7 AIRPLANE VORTEX DRIFTING ACROSS TEST SITE. (NOTE SAME VORTEX AS IN FIGURE 20.) NOTE ONSET OF SPIRAL FLOW AND VORTEX BURSTING.

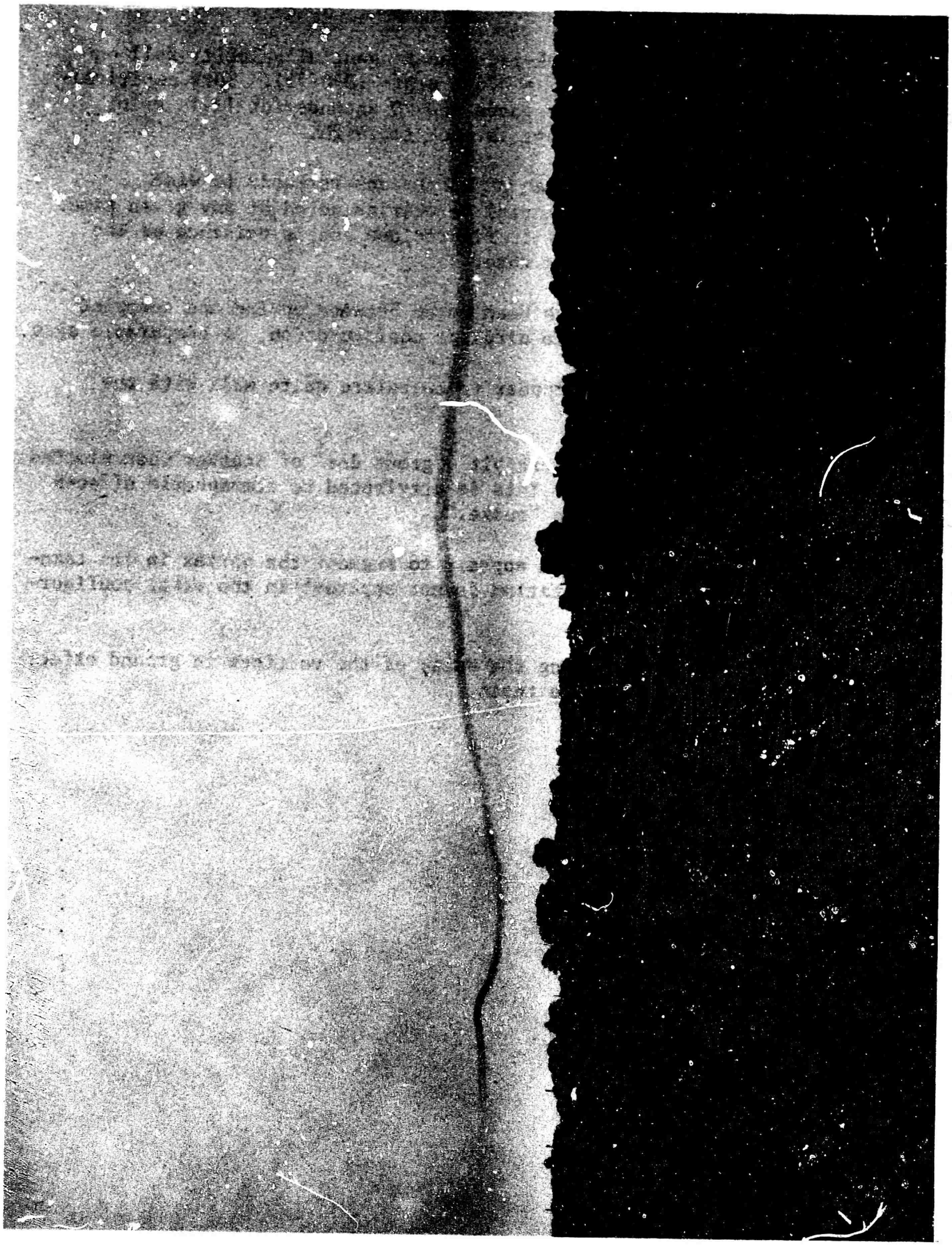


FIGURE 22. DC-7 AIRPLANE VORTEX SHOWING ONSET OF SPIRAL FLOW IN CERTAIN SEGMENTS AND BREAKDOWN.

CONCLUSIONS

1. All data points obtained on peak-recorded tangential velocity fall on or under an exponential curve $V_{\theta\,max} = 476.8 \exp(-.03067t)$. This empirical result is substantiated between 30 seconds and 70 seconds for 't.' Prior to 30 seconds, it yields a result that is much too high.

2. The use of 4-foot spacing between adjacent sensors leads to wide variation in the peak-recorded tangential velocities noted at any given time. This has bee ted for all airplane configurations and is evidence of the existence of a small diameter vortex core.

3. No significant differences have been noted between upwind and downwind vortices, when compared for the same airplane configuration, at comparable ages.

4. Lateral transport velocities appear to correlate quite well with the estimated crosswind velocities.

5. Vertical transport velocities exhibit a great deal of scatter when plotted against the potential flow values. This is attributed to atmospheric effects and the tendency of the vortices to "snake."

6. Like rotation of the slipstream appears to augment the vortex in the take-off configuration, but this augmentation is not apparent in the other configurations.

7. The effect of wind in hastening the decay of the vortices in ground effect has not been clearly shown in these tests.

REFERENCES

1. Anon, Central Data and Recovery System, CENDAR, SRDS FAA Report, September, 1964.

2. Schrenk, O., A Simple Approximation Method for Obtaining the Spanwise Lift Distribution, NACA TM 948, August, 1940.

GLOSSARY

List of Symbols

b	Airplane geometric span, ft.
C_L	Airplane lift coefficient.
s	Semidistance between members of trailing vortex pair, downstream, out of ground effect, ft.
S	Airplane wing area, square ft.
t	Elapsed time, seconds.
T	Vortex descent time, seconds
V	True airspeed, feet per second.
x	Longitudinal distance, feet.
y	Lateral distance, ft.
z	Vertical distance, ft.

APPENDIX A

DC-7B AIRPLANE GENERAL SPECIFICATIONS

Wing Span (feet)	117.5
Wing Area ($feet^2$)	1463
Aspect Ratio	9.5
Root Chord (at fuselage centerline (C_L)	19.05
Tip Chord (feet)	5.88
Take-off Weight (lb)	122,200
Take-off speed (knots)	125
Flap Setting (degrees)	20
Max. Landing Weight (lb)	95,000
Landing Speed (knots)	111
Flap Setting (degrees)	50

(See Figure A-1)

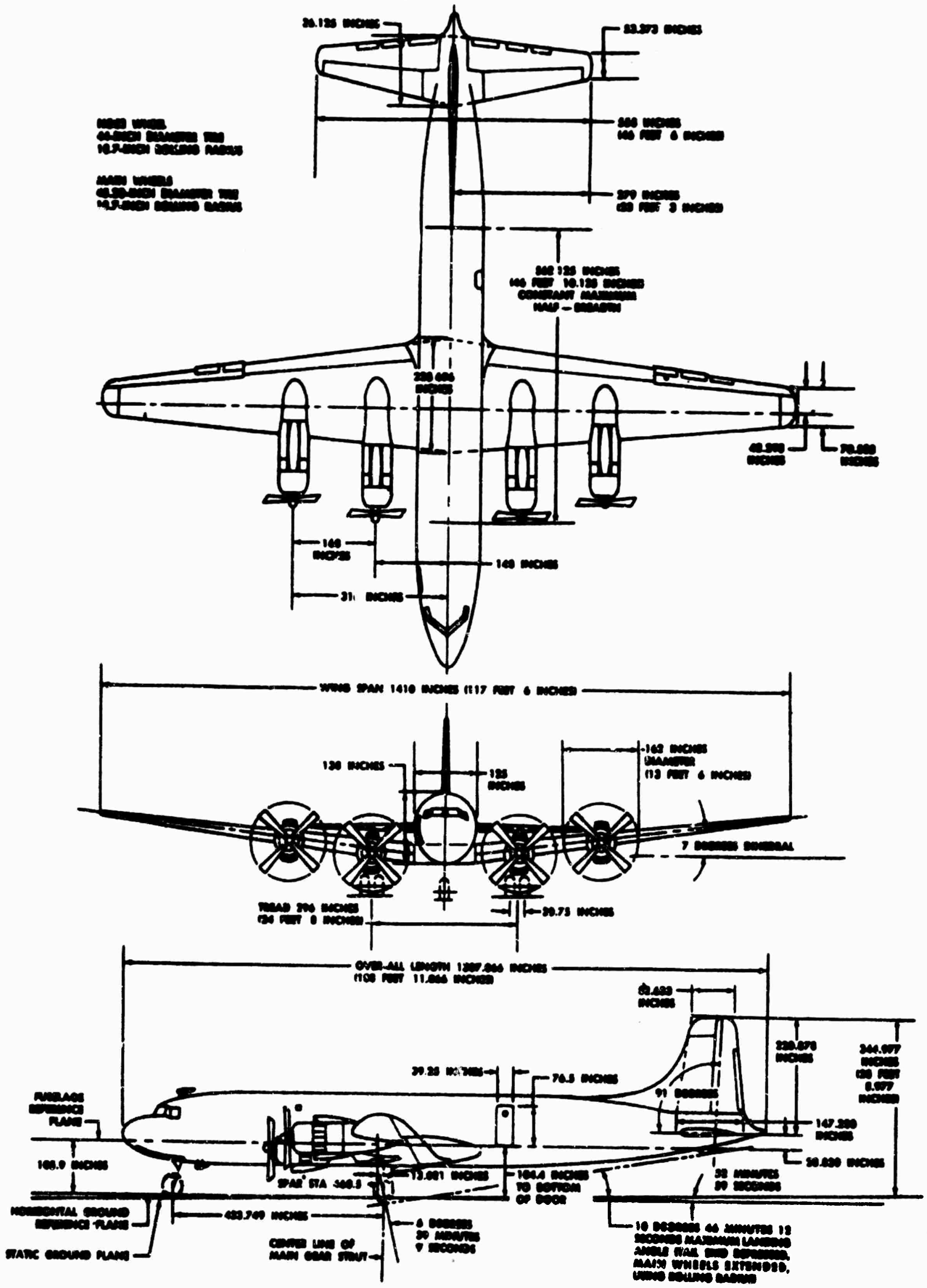


FIGURE A-1. DC-7B AIRPLANE DIMENSIONS.

APPENDIX B

TOWER INSTRUMENTATION

INSTRUMENTED TOWER.

The tower is located at a point 2,456 feet from the centerline of Runway 13-31. It is 140 feet high with its base 76 feet above sea level. The tower is self-supporting, of triangular cross section, so designed to present low blockage to air currents from any direction and accordingly, causing little interference with air flow measurements.

The tower was instrumented with hot-film anemometers to measure vortex airflow velocity. Vortex direction was observed through the use of colored motion pictures and colored smoke dispensers, the smoke being entrained in the passing vortex system, thus producing a visual indication of its movement and structure. Instrumentation and smoke dispensers were located as shown in Figure B-1.

INSTRUMENTATION TRAILER.

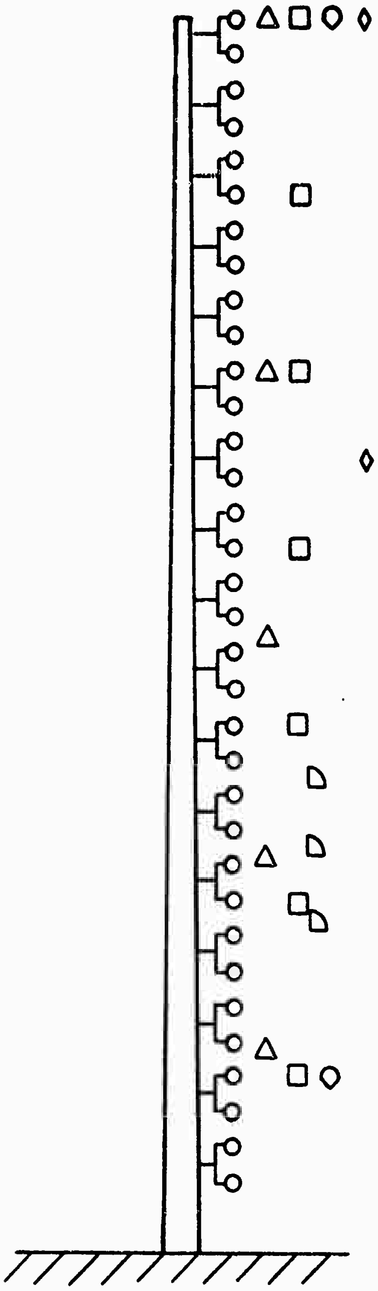
A 10- by 40-foot instrumentation trailer was located approximately 60 feet northeast of the tower and was used to contain the recording equipment, necessary electronic accessories, and served as a control room for all recordings. The location was selected to be generally downwind or crosswind from the tower during most flights. In this location, the trailer did not disturb the airflow pattern prior to the vortex penetration through the tower.

TEST INSTRUMENTATION.

The sensors mounted on the tower were divided into two groups. Group One consisted of 34 hot-film anemometers, capable of recording velocities up to 250 ft/s at frequencies well above 1,000 Hz. These were installed at 4-foot increments, starting at 8 feet and terminating at the 142-foot level, and were mounted on the ends of movable booms that extended approximately 10 feet from the center of the tower, and were aligned in a single vertical line. Each anemometer was mounted on a protractor fixture installed at the end of the boom, adjustable over a ± 90° range. The range of coverage was 130° through 310° magnetic (Figure B-2).

The hot-film sensors were mounted with the axis parallel to the ground. They were ligned through the use of the protractor fixture so that the axis was perpendicular to the direction of the ambient wind. This position allowed the tangential velocity of the vortex to impact the hot-film sensor in a normal plane. Axial flows are not detectable by this system. In the event that the ambient wind was in the range of 310° through 130°, the sensors were aligned downwind, keeping the axis still perpendicular to the wind. With these conditions, the turbulence around the hot film resulted in what appeared to be a noisy output. However, this noise disappeared or was minimized when the vortex penetrated the hot-film area.

SENSOR LOCATIONS, VORTEX TOWER,
SEPTEMBER THRU DECEMBER, 1971



- o Hot film anemometers (34), single axis located at 4' increments between 8' and 140'.
- △ Five levels of wind velocity, direction and temperature at levels of 23', 45', 70', 100' and 140'.
- O Humidity sensors at levels of 23' and 140'.
- ◊ Pressure sensors at levels of 93' and 140'.
- □ Smoke dispensers located at 20' increments between 20' and 140'.
- D Total vector velocity hot film anemometers located at levels of 38', 46', and 54'.

FIGURE B-1. SENSOR LOCATIONS, NAFEC VORTEX TOWER.

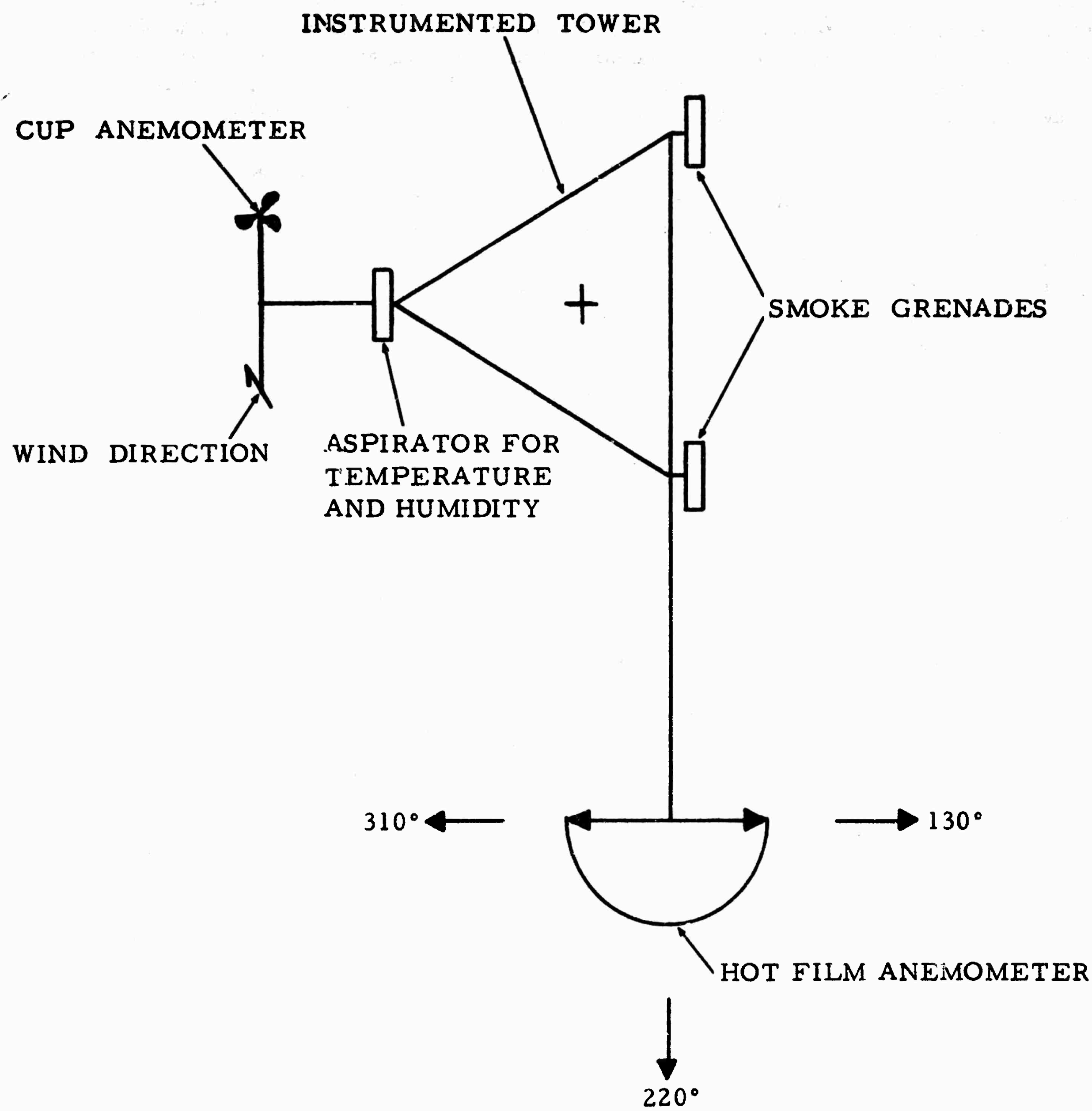


FIGURE B-2. ANEMOMETER LOCATIONS AT VORTEX TOWER SITE.

The sensors were manufactured by Thermo-Systems, Inc. They utilize the "constant resistance" mode of operation in which a voltage is a measure of the cooling effect of the wind, which is directly related to wind velocity. The output voltage of the bridge is in the range of 4 to 14 volts, which represents wind velocities of zero to 210 ft/s. Figure B-3 is a schematic of the basic circuit. In order to have the anemometer output compatible to normal recording system standards, a zero suppression circuit and a gain control circuit was added to have a zero to 5-volts output for zero to 210 ft/s velocity.

Group Two sensors consisted of standard meteorological instruments to measure the low-frequency components of the atmospheric conditions. Cup-type anemometers, wind direction sensors, and temperature sensors were located on five levels, with approximately logarithmic spacing. Two humidity sensors were installed, one at the 23-foot level, the other at the 140-foot level. The temperature and humidity sensors were located in ventilated, shielded housings to minimize effects of solar radiation.

Two pressure sensors were mounted on the tower, one at the 93-foot level and the other at the 140-foot level. They were used to obtain information relative to the pressures within the vortex core.

CALIBRATION AND ROUTINE CHECKS.

Single-axis hot-film anemometers were calibrated periodically by use of a laminar flow air velocity calibrator. Each anemometer was calibrated at 21 points, zero to 211.68 fp/s. The square root of the velocity vs. the square of the voltage was plotted and an equation in the form of:

$\sqrt{\text{velocity}} = A_1 + (B_1 \times \text{voltage}^2)$, was obtained. At the start of each data run, reference voltages of zero and 5.00 volts were substituted for the anemometer outputs. These reference voltages were used in the computer program to properly scale the voltage outputs from the anemometers.

Early in the testing, efforts were made to calibrate the anemometers after two weeks of use. More frequent calibrations were desired, but proved to be impractical due to the heavy test schedule and the long period of time necessary to remove the sensors from the tower, calibrate each of the 34 sensors at 21 points and re-install them on the tower. A definite degradation of the anemometer output was noted after the two-week test period, which resulted in an error band of $\pm$ 10 percent of the full scale reading. Later in the tests, the anemometers were tested at the end points of zero and 210 ft/s. If the output was within $\pm$ 1 percent of the previous reading, no changes were made. If the output was beyond $\pm$ 1 percent, the amplifiers were reset and a new calibration obtained.

The continuing calibration of the anemometers was necessitated by persistent drifting.

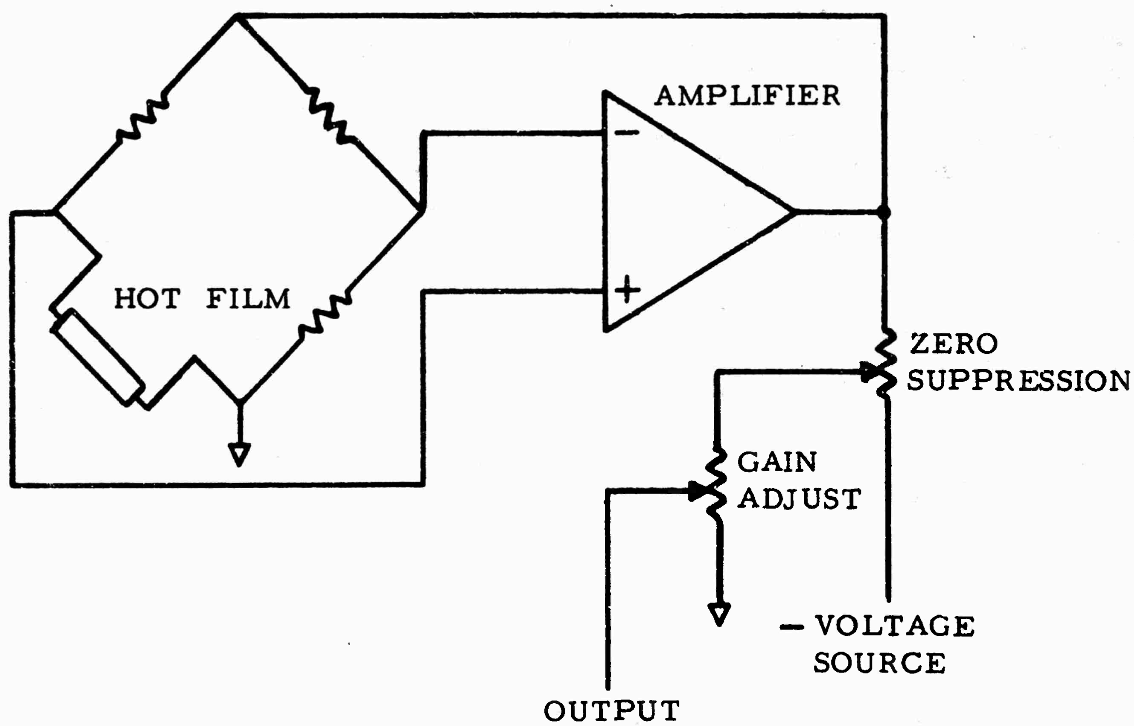


FIGURE B-3. BASIC OUTPUT VOLTAGE CIRCUIT, SCHEMATIC DIAGRAM.

The total velocity-vector anemometers have a built-in system for calibration that performs as follows: A shield is positioned over the hot-film sensors in order to obtain zero air flow. Shield operation is controlled remotely. A flow of air, controlled by a sonic orifice and a pressure regulator, is allowed to flow past the sensor while the shield is in position. This results in a second point along the velocity vs. voltage curve. These outputs, under the two set conditions, are used by the computer to properly scale the voltage output. These tests were made prior to each data run. During the data run, the calibration air source was shut off and the shield withdrawn to expose the sensing film.

Due to the relationship of velocity = K voltage^4, the error percentage at the lower velocities was less than at full scale, where it reached ±10 percent of full scale. Calibration experience gained with the calibration of over 100 anemometers indicated that errors were in the order of ±5 ft/s in the lower velocity range of zero to 21 ft/s.

The cup-type anemometers were calibrated at the factory and these values were used during the test. After a month's operation, they were returned to the factory for re-calibration. Accuracy was within ± 0.5 miles per hour (mi/h) in the range of 2 to 30 mi/h. The threshold velocity was 1 mi/h with a distance constant of 5 feet.

The wind direction sensors were calibrated at NAFEC and were within ± 6° of true wind direction. This error was due primarily to the inability to accurately align the sensor in a given direction. The dead-band area was 3°, which was set at 357° to 360°. The distance constant was 3.5 feet. Initial recording problems arose which invalidated the output data. Therefore, hand-recorded data was obtained when required.

Although a considerable effort was made to accurately record temperatures on five levels of the tower, oscillation in the electronic circuits due to the 200-foot distance between the resistance sensor and the electronics resulted in unreliable outputs.

Relative humidity measurements were made at the 23- and 140-foot level. An amplifier failure on the 140-foot sensor prevented the recording of the signal. The error band of the sensor at the 23-foot level was ± 3 percent of full scale between relative humidities of 10 and 90 percent.

Prior to test periods, all signals were checked for condition and the status recorded on the Daily Checkoff Sheet. Time would not permit the repair of malfunctioning signals prior to the test. However, every effort was made to have all signals functioning for the next testing period.

During the test periods, the real-time output of an oscillographic recorder was monitored to determine the functioning of the hot-film sensors and calibration voltages.

DATA COLLECTION SYSTEM.

Figure B-4 is a block diagram of the flow of signals to the data recording systems. During tests, data was recorded on two systems as follows:

1. Analog Magnetic Tape Recorder. This system was considered primary and all signals as listed on the Daily Checkoff Sheet (Figure B-5) were recorded on it. Referring to Figure B-4, all incoming signals are routed through signal conditioners where they are standardized to a range of zero to 5 volts. A second function of the signal conditioner is to substitute reference voltages in place of the incoming signals. This substitution of voltages is usually referred to as calibration and uses two voltages, zero and 5 volts dc.

The electrical signals are then routed to voltage-controlled oscillators where the voltage is changed to a specific frequency range. Fifteen proportional bandwidth Voltage Controlled Oscillators (VCOs) with center frequencies ranging from 400 Hz to 30,000 Hz are summed and the output signal is recorded on one track of the seven-track analog magnetic tape recorder. During these tests, five tracks were dedicated to the FM multiplex from the VCOs; one track for voice, and the remaining tracks for central time.

The frequency response of the VCO varies directly with the frequency bandwidth. The higher frequency VCOs were reserved for hot-film anemometer data. However, all hot-film data could not be on high frequency VCOs. For instance, VCO No. 8, having a frequency response of dc to 45 Hz was used on levels of 8, 12, 16, 20, and 24 feet. VCO No. 15 have a frequency response of dc to 450 Hz and were used on levels of 48 and 52 feet, plus some of the total velocity-vector anemometers. The result of such a combination was that upon vortex penetration of the measuring complex, the higher frequency VCOs appeared to be more active or "noisier" than adjacent sensors.

2. Oscillographic Data System. A 36-channel direct-writing oscillograph was connected to 33 of the 34 single axis hot-film anemometers, one film of a total velocity-vector anemometer, an event signal, and NAFEC time. The oscillographic data system was used for real-time monitoring of the hot-film data, calibration signals, and vortex "hits" on the tower. After each series of flight tests, the oscillograph output was edited to determine: (1) the vertical location of the vortex "hits" on the tower, (2) the time interval between the first and second vortex, and (3) the time interval between passage of the aircraft past the tower and the vortex "hits." This editing greatly reduced the time required for subsequent data processing, since only pertinent data was processed.

AIRCRAFT SPACE POSITION.

The phototheodolite range was used to track the aircraft in the vicinity of the vortex test tower. Three phototheodolites were normally used for tracking with the best two being used for the solution. Data obtained from the theodolite included groundspeed and track of aircraft, altitude, and horizontal distance

TESTING PERIOD, SEPTEMBER - DECEMBER, 1971
VORTEX TESTING, XONICS

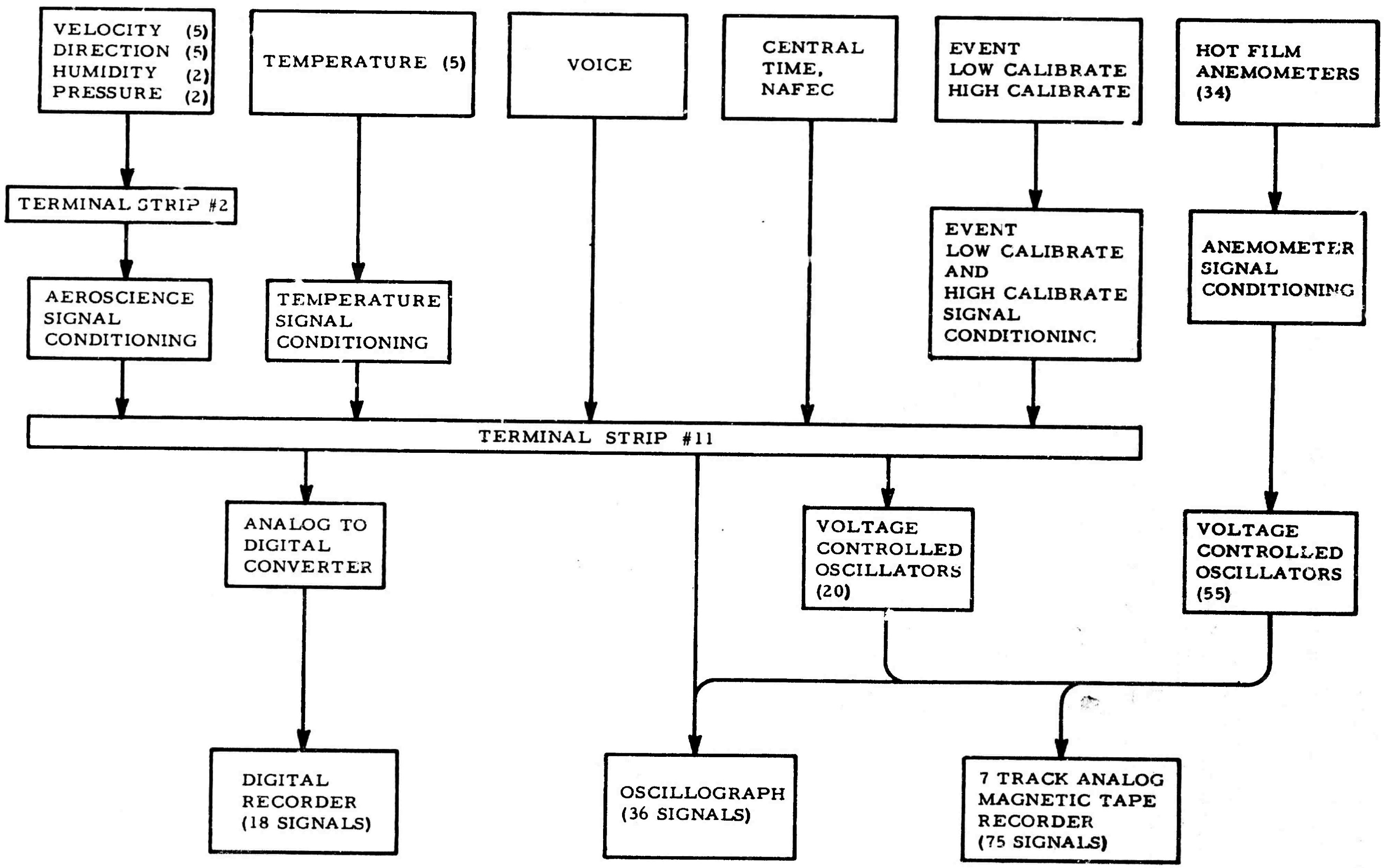


FIGURE B-4. DATA COLLECTION SYSTEM DIAGRAM.

SIGNAL	TS	VCO		SIGNAL	TS	VCO	
Vel. 8	68	E8	✓	Cup 23	48	D3	✓
12	53	D8	✓	" 45	49	D4	✓
16	38	C8	✓	" 70	50	D5	X
20	23	B8	✓	" 100	51	D6	X
24	8	A8	✓	" 140	52	D7	✓
28	69	E9	✓				
32	54	D9	✓	Dir 23	63	E3	✓
36	39	C9	✓	" 45	64	E4	✓
40	13	A13	✓ Low	" 70	65	E5	✓
44	59	D14	✓	" 100	66	E6	X
48	60	D15	✓	" 140	67	E7	✓
52	75	D7	✓				
56	74	E14	✓	Hum 23	2	A2	✓ 1.51V
60	28	B13	✓	" 140	47	D2	X
64	43	C13	✓				
68	58	D13	✓	3D1 A1	15	A15	✓
72	73	E13	✓	A2	14	A14	✓
76	12	E14	✓	B1	7	A7	✓
80	27	B12	✓	B2	6	A6	✓
84	42	C12	✓	C1	5	A5	✓
88	57	D12	✓	C2	4	A4	✓
92	72	E12	✓	T	3	A3	✓ 2.06V
96	11	A11	✓				
100	26	B11	✓	3D2 A1	30	B15	X
104	41	C11	✓	A2	29	B14	✓
108	56	D11	✓	B1	22	B7	✓
112	71	E11	✓	B2	21	B6	✓
116	10	A10	✓	C1	20	B5	✓
120	25	B10	✓	C2	19	B4	✓
124	40	C10	✓	T	18	B3	✓ 1.80V
128	55	D10	✓				
132	70	E10	✓	3D3 A1	45	C15	✓
136	9	A9	✓	A2	44	C14	✓
140	24	B9	✓	B1	37	C7	✓
				B2	36	C6	✓
T23	32	C2	✓ 3.76V	C1	35	C5	X
T45	16	B1	✓ 2.04	C2	34	C4	✓
T70	17	B2	✓ 3.45	T	33	C3	✓ 1.81V
T100	61	E1	✓ 2.95	Event	2	A2	✓
T140	62	E2	✓ 2.61	"	16	B1	
				"	32	C2	
P Core	31	C1	X	"	46	D1	
P Baro	1	A1	X	"	61	E1	

TEMP SWITCH POSITIONS

23	3
45	3
70	3
100	3
140	3

Baro. Press ________
Humidity ________
Probe angle 280° *
Time 0815
Date 9-1-71
* Downwind

Aircraft DC-7
Run numbers 61 - 72

✓ Indicates signal satisfactory
X Indicates signal is no good.
Comments are to be placed on back of this form. AAH

FIGURE B-5. SAMPLE OF DAILY CHECKOFF SHEET, INDICATING SIGNALS NOT OPERATING

from the aircraft to the tower. Time zero, which is defined as the time that the aircraft crossed a perpendicular line to the tower, was also obtained from the theodolite data.

SYNCHRONIZATION OF ALL DATA SOURCES.

Synchronization of the phototheodolite, analog magnetic tape, and the oscillograph was through a central time source synchronized to Radio Station WWV. As the aircraft passed the tower, an operator pressed a switch that placed an event mark on the analog tape, digital tape, and the oscillograph. In addition, it ignited a large photo flashbulb on the tower that was within range of all data cameras and started an elapsed-time clock that was also in the range of the data cameras. In this manner, all data sources were synchronized by time. A check on the accuracy of the time zero-switch operation was obtained by checking that time against the time that the theodolites indicated for the shortest distance between the aircraft and the tower.

EQUIPMENT MALFUNCTIONS.

Some loss of data occurred during the tests due to malfunctioning equipment. Some of the malfunctions were observed at the start of each testing period, but repair could not be accomplished in the short time period available. Other malfunctions did not become known until computer output was available. There was only one test period in which all 34 single-axis anemometers were good. On average, 30 of the 34 single-axis anemometers functioned properly.

The total velocity-vector anemometers were damaged on several occasions when foreign material struck the fragile sensors and broke them. It proved impossible to keep the air supply hose to the total velocity-vector anemometer from leaking. The hot debris from burning grenades, used for smoke generation, constantly burned holes in the air lines. Since most of the time was spent on keeping the necessary equipment in commission, the total velocity vector system was not used for these tests.

The cup-type anemometers and direction vanes generally worked. Some data was lost when bearings became sticky. Usually, bearing replacements put them back in operating condition.

The temperature results have already been discussed and generally were of little use for determining lapse rates. The 45- and 70-foot temperature sensors worked throughout the testing period and were satisfactory for ambient temperature measurements.

Other instrumentation that was to be used, but which failed early in the tests included two sensitive pressure transducers intended to detect the pressure within the vortex. Both failed due to the high overpressures generated.

APPENDIX C

DATA PROCESSING

DATA FORMAT REQUIREMENTS.

The signals from the tower instrumentation were properly conditioned to voltage-controlled oscillators in the FM Multiplex System as shown in Appendix B, Figure B-4.

DATA SCHEMATIC FLOW.

A schematic of information flow is shown in Figure C-1. Data was demultiplexed, unpacked, calibrated, and floated by the 7090 computer program. The output consists of calibrated velocity curves grouped by individual sensors along with the associated meteorological information. Data for each sensor appears in chronological order in floating point format. The data retrieval program including calibration, conversion, format plot subroutine, and selected variable time history output is shown in Figure C-2.

DATA RETRIEVAL.

The multiplexed CENDAR data is checked for validity by investigating such items as "0" bit error, time word error, tape redundancy, data channel malfunctions, and record word count error. During demultiplexing, data was grouped according to each sensor and then outputted. During unpacking and floating, data words were broken down into bytes and decoded into floating point format. The history of data retrieval was then outputted for future reference.

X = CENDAR tape data value in units of volts.

Y = Calibrated data value in units of ft/s.

P_H and P_L values with accompanying sensor voltages are obtained at the probe calibrated standard conditions (70°F, 29.92" Hg). To compensate for atmospheric conditions, all versions of the CII Program multiply these values by the following factor:

$$\left[\frac{(29.92)(T+460)}{530(P)}\right]$$

Where T = ambient temperature in degrees fahrenheit
P = ambient pressure in inches Hg

The hot-film sensors operate at a steady temperature of 450° at standard conditions. To compensate for non-standard operating conditions, the CII M3-1*, CII M3-1**, CII M5, and CII M6 Programs, multiply M and B by the following factor:

$$\left[\frac{380}{450-T}\right] = \frac{450-70}{450-T}$$

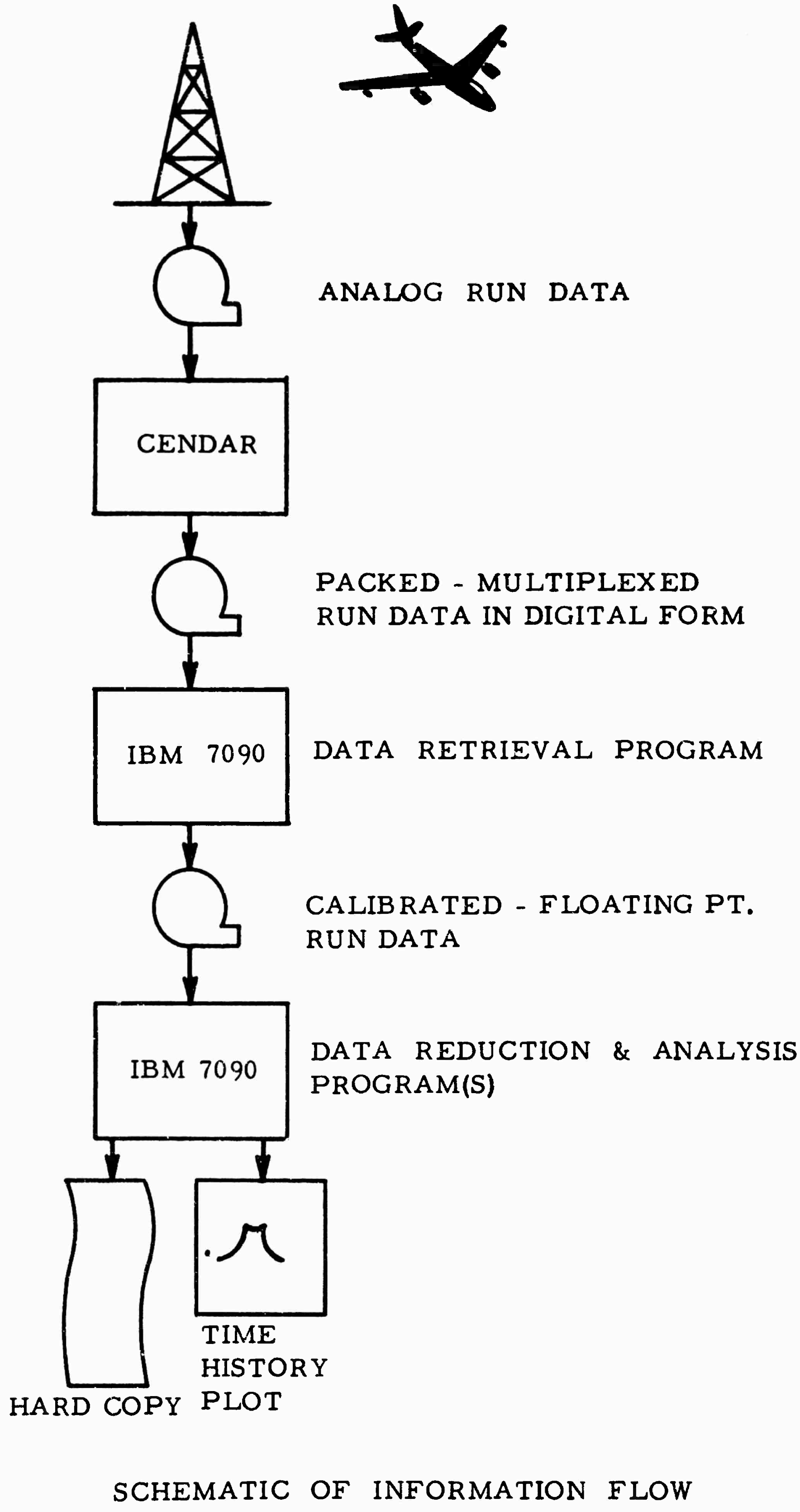


FIGURE C-1. SCHEMATIC OF INFORMATION FLOW.

DATA RETRIEVAL PROGRAM

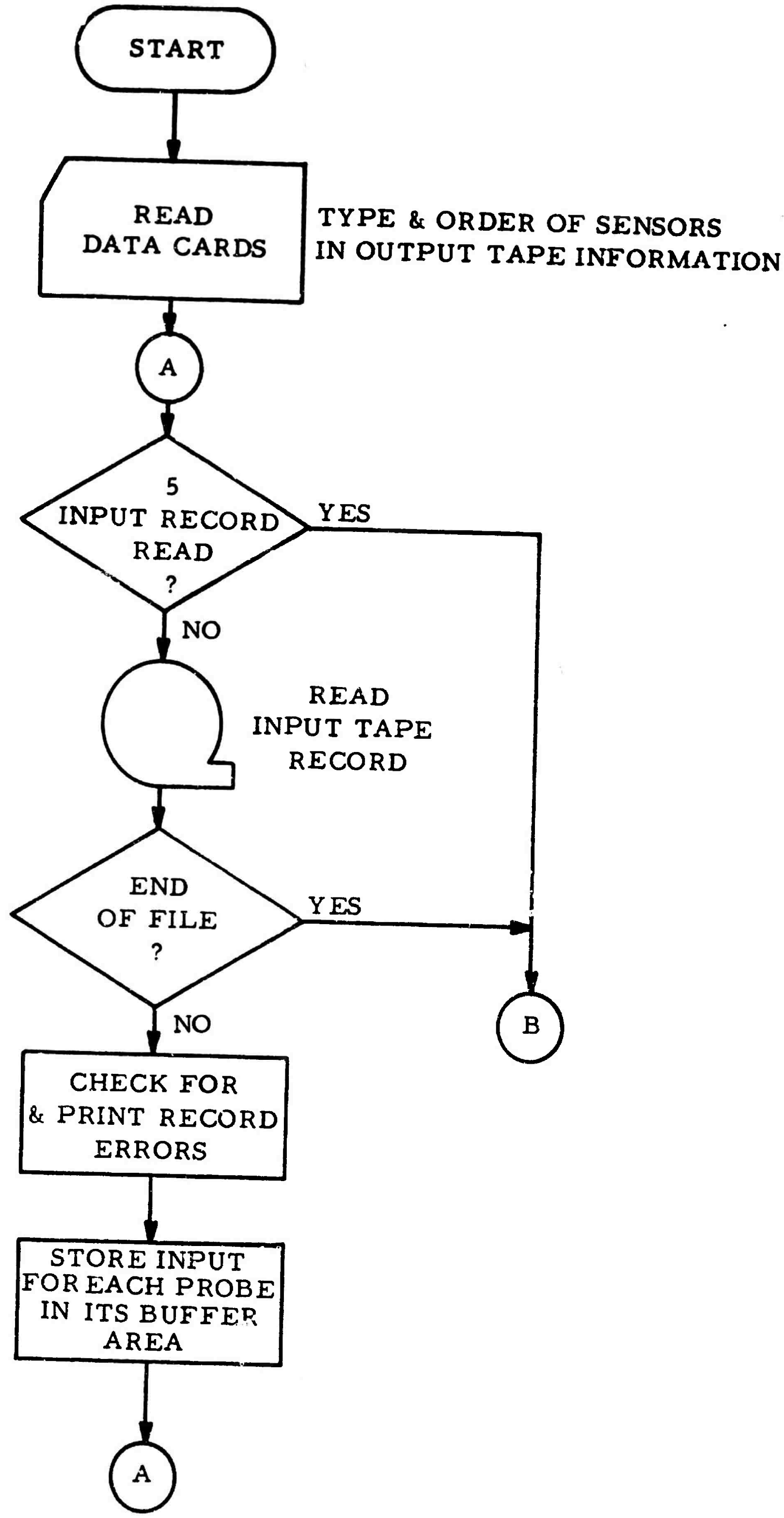


FIGURE C-2a. DATA RETRIEVAL PROGRAM.

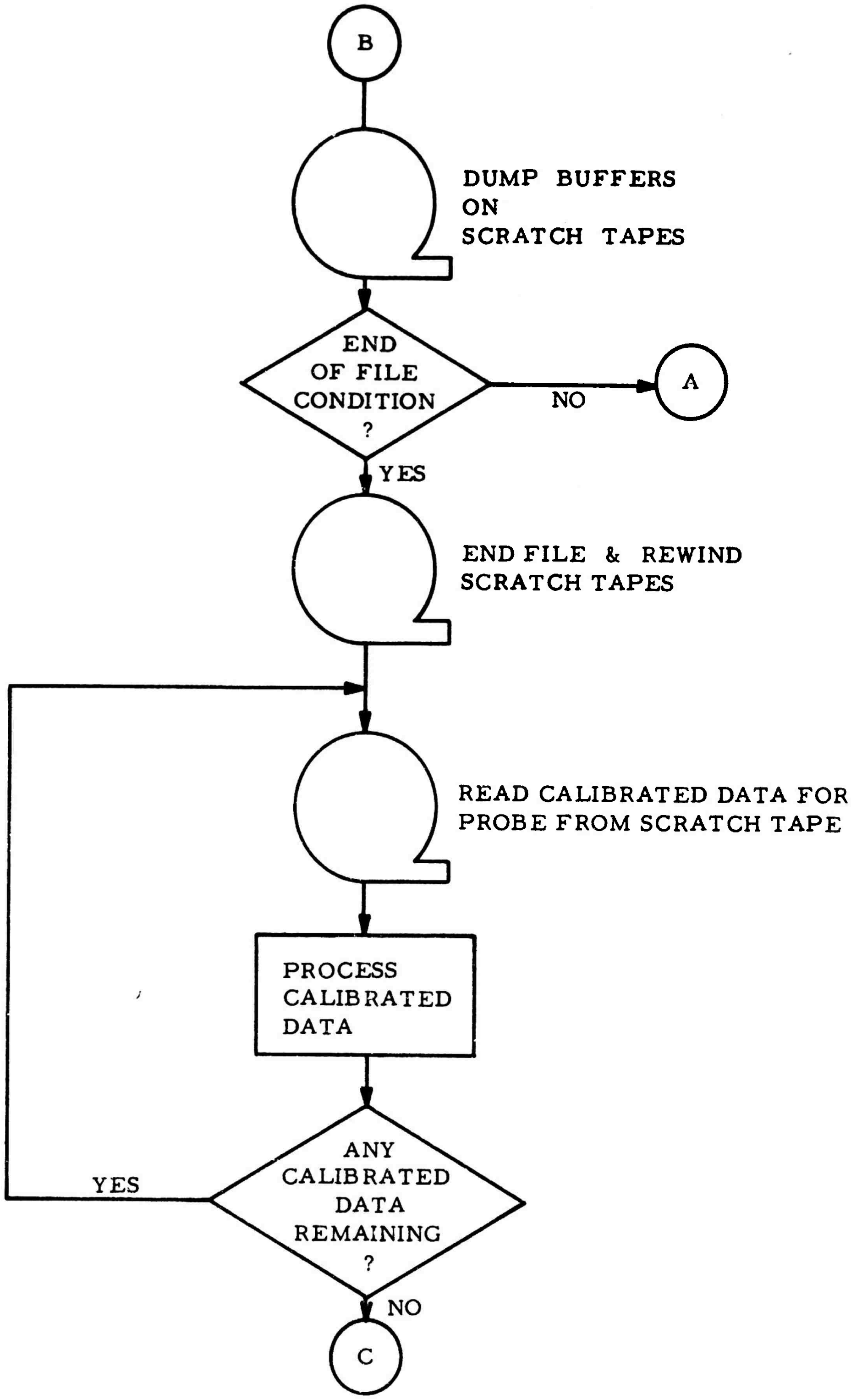


FIGURE C-2b. DATA RETRIEVAL PROGRAM.

DATA RETRIEVAL PROGRAM (CONT'D)

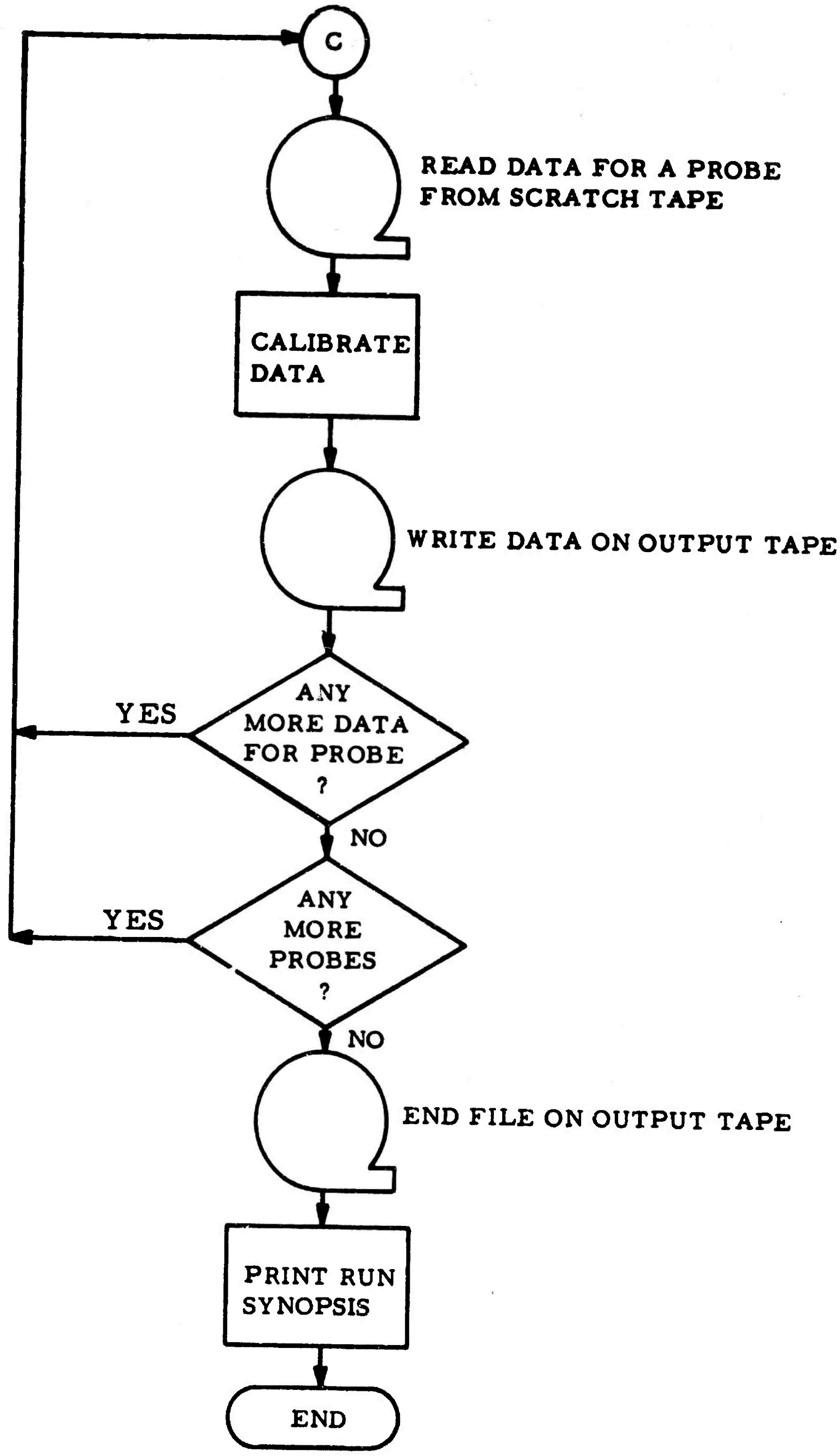


FIGURE C-2c. DATA RETRIEVAL PROGRAM.

COMPUTER PROGRAMS.

There are two basic data collection computer programs being used by this project. The first is entitled CENDAR II, Modification I (CII MI). It operates upon digitized raw data yielding calibrated data and a processing history. The second program is entitled Plot II (PII). It accepts calibrated data as input and yields a tape formatted for use on a data plotter.

Three data plotters have been used on this project. Originally, NAFEC used an EAI-3440 plotter. This was replaced by a CalComp-718. The Naval Weapons Laboratory, Dahlgren, Va., also has a CalComp-718 which is available to NAFEC. Because none of these machines have compatible input format requirements, there is a profusion of plot programs. It has also been found expedient to change or add features to these plot programs from time to time. However, the output (plots) have remained unchanged. The modifications are, therefore, of little interest to anyone but NAFEC's operational personnel and will not be discussed. All plot programs yield a time history of tangential velocity versus elapsed time. Each normal plotted point is the average of 50 data values (0.050 sec). The averaging has a low-pass filtering effect and also reduces the number of plotted points to a manageable size. Expanded plots have an adjustable time scale i.e., less than 50 data values per plot point, and, therefore, the low-pass filter characteristics will also vary. A schematic of the sensor plot program is shown in Figure C-3.

The CII MI Program has been used to process this data. A brief description of the CII Program series is included for completeness:

CII (4/15/71). This program was developmental in nature, being written before all project requirements were available and was never used in production.

CII MI (5/10/71). This is the first production program. It can process five files of input data (75 sensors). The sensors can be one-dimensional linear or fourth-order calibrated, or three dimensional. However, a three-dimensional sensor displaces seven one-dimensional sensors. Up to three, three-dimensional sensors may be processed per run. Three-dimensional sensors have not been processed to date and the CII M4 Program is being developed to handle this type sensor more efficiently and with fewer restrictions.

CII PROGRAM SERIES LOGIC.

This FORTRAN IV and MAP Program is intended to be run on the IBM 7090 Computer. It requires two data channels with seven tape drives per channel.

There are three types of internal program tables:

Type 1. Tables remain more or less constant. These tables contain values related to particular sensors and need only be updated when a sensor's calibration changes or a sensor is replaced. Updating is accomplished by NAME LIST Cards.

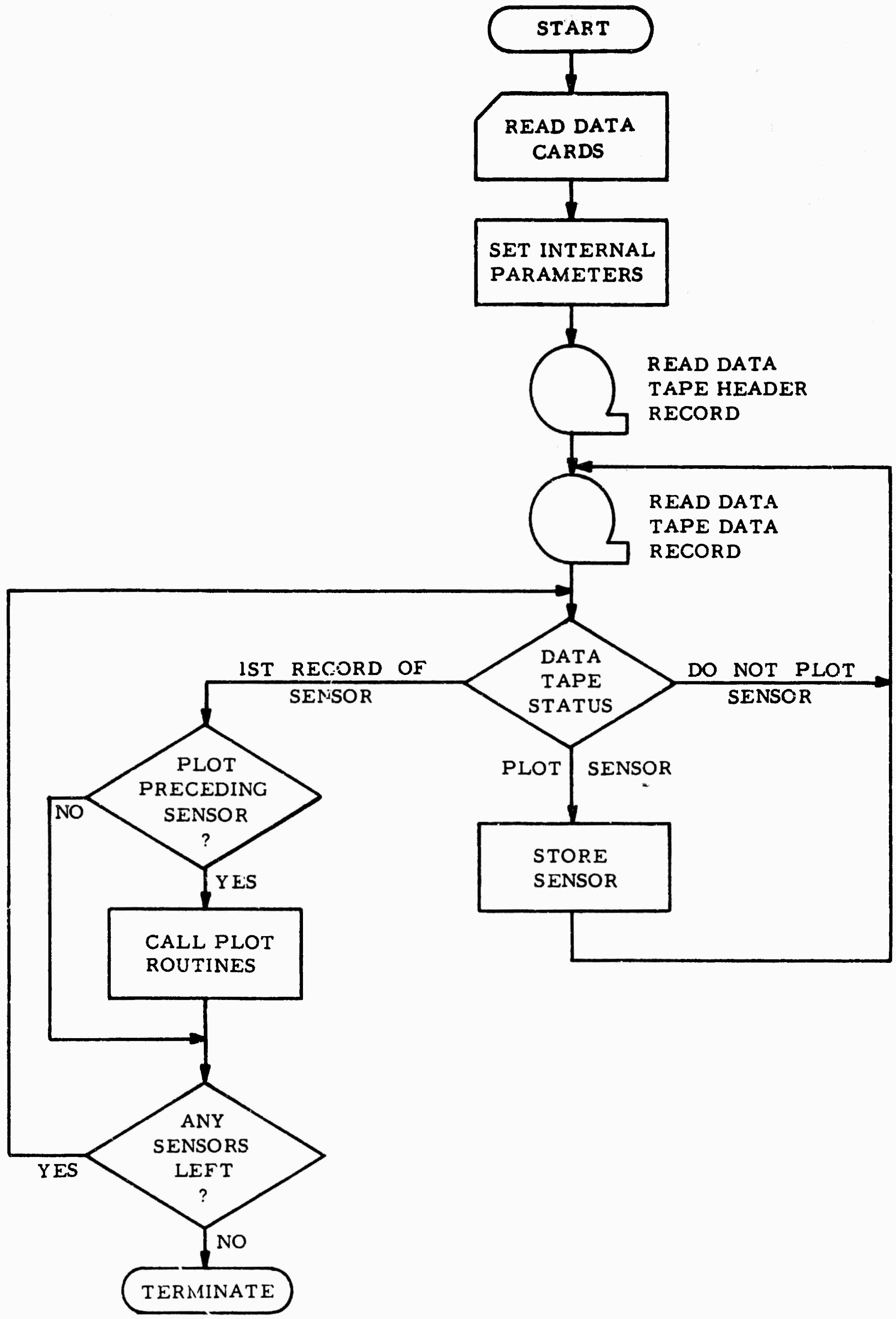


FIGURE C-3. SCHEMATIC OF PII PROGRAM SERIES.

Type 2. Tables remain constant for the duration of a single run. Atmospheric conditions, sensors to process, header information, etc., fall into this category. These tables are updated using data cards.

Type 3. Tables are updated for each run, but this is done automatically by the program using input data and values from Tables Type 1 and 2 above. CENDAR calibration values, maximum tangential velocity tables, etc., appear in this class. When the program goes into execution, it reads the NAME LIST Cards, if any, and data cards. Appropriate tables are updated. The input file contains 20 records of low-calibration values and then 20 records of high-calibration values followed by data values. All input on tape is multiplexed. The program reads the low-calibration values and finds the mean ($\bar{X}$) and standard deviation $\bar{\sigma}$ for each sensor. A second look is taken at this data and all values outside the limits $\bar{X} - \bar{\sigma}$, $X + \bar{\sigma}$ are discarded. A new mean $\bar{\bar{X}}$ and standard deviation $\bar{\bar{\sigma}}$ are found and outputted as part of the processing history. The $\bar{\bar{X}}$ value is stored in a table of low-calibration tape values. This same algorithm is followed for obtaining the high-calibration values.

There are actually three sets of calibration values for low- and also for high-calibration of each sensor. The sensor voltage value related to a particular physical parameter, the physical parameter itself, and the CENDAR tape calibration values. It is necessary to relate the CENDAR values which are in units of volts to the sensor calibration values in units of volts and then obtain the physical value represented by a particular sensor output.

Once the sensors have been calibrated, the data is read into the core in blocks of five physical records. Only the first sensor in use for the current file is calibrated and outputted. The other sensors are demultiplexed and written on scratch tapes. When an "end-of-file" is sensed, on the input tape, the scratch tapes are rewound and their contents processed and outputted one sensor at a time. Just before a sensor's data is written on the output tape, it is calibrated and checked for maximum value and related time. The program continues processing data until all desired sensors are processed. Routines are incorporated to skip files which contain no useful data. Extensive quality control procedures are observed to monitor the input data, scratch tape data, and time.

The program prints out quality control tables which form part of the processing history and are retained; it is therefore possible to check on the data of any given run, in case of questionable output. A table of maximum values is also outputted. Caution is necessary when using this table because of the possibility of the vortex magnitude associated with the far wing tip exceeding the normally greater magnitude of the near wing tip vortex. Times associated with vortex hits are outputted to resolve this difficulty.

PPI PROGRAM SERIES LOGIC.

This FORTRAN IV Program is intended to be run on the IBM 7090 Computer. It requires two data channels with one tape unit per channel. Data cards are used to describe various parameters such as sensors to plot scale factors for abscissas and ordinates, number of data points to average per plot point, etc. CII output is inputted to this program. The calibrated data for the various sensors processed appears in serial fashion on this input tape. PII processes up to 3,000 plot point data values for any requested sensor. It then outputs on the plot tape using standard CalComp subroutines. When all required sensors for a given run are processed, the data plotter accepts the plot tape and plots a time history for each sensor. There are two distinct noncompatible sets of CalComp subroutines, one for NAFEC and one for Dahlgren's 712 CalComp Plotter.

Programming efficiency dictated a variation in algorithms used to determine maximum tangential velocities in the CII Series and the PII Series of programs. The CII Series operates upon 50 consecutive legal data values while the PII series operates upon legal values contained within 50 consecutive data values. The operation of either program consists of finding the mean data value and checking it against the existing maximum mean data value. When the maximum mean is redefined, its associated time is declared as the median time value associated with the group of data values related to the new maximum mean. If there are no illegal data values, the results of these two algorithms are identical. However, divergence occurs in proportion to the degradation of quality of input data. The quality of input data so far has been high, so this has posed no real problem.

CII PROGRAM MATHEMATICS

In order to remove spurious values from calibration data, the program performs the following computations on the first 40 records of each file. The first 20 records contain low-calibration values, the next 20 high-calibration values. An indication of the quality of calibration values, and quite probably, test data values also, can be obtained by noting the number of calibration points, N', used in the final calculations of $\overline{X}_H$ and $\overline{X}_L$.

$$X = \frac{\Sigma Xc}{N} \qquad \text{Raw mean}$$

$$\sigma = \left[\frac{\Sigma Xc^2 - (\Sigma Xc)^2/N}{N-1}\right]^{1/2} \qquad \text{Raw standard deviation}$$

Where Xc = input tape calibration value (-10V <Xc< +10V)

N = number of x values (840) - number values in the absence of "O-Bit" errors.

Let the set X^1c values consist of all X values satisfying the criterion

$$\overline{X} - 1\sigma < X$$

$$\overline{X} - 1\sigma < Xc^1 < \overline{X} + \sigma$$

$$\overline{\overline{X}} = \frac{\Sigma Xc^1}{N^1}$$

$$\overline{\sigma} = \left[\frac{\Sigma (X^1)^2 - (\Sigma X^1)^2/N^1}{N^1-1}\right]^{1/2}$$

$\overline{X}$, $\overline{\sigma}$, $\overline{\overline{X}}$, and $\overline{\overline{\sigma}}$ are calculated separately for both low- and high-calibrations. $\overline{\overline{X}}$ is used in calibration of data, N', and $\overline{\overline{\sigma}}$ are outputted along with $\overline{\overline{X}}$ in processing history.

This routine remains unchanged in all versions of the CII Program.

Test data is calibrated by using a linearized calibration as shown in Figure C-4.

Sensor data is calibrated using the following expression:

$$Y = MX + B$$

$$M = (P_H 1/2 - P_L 1/2) \,/\, (\overline{\overline{X}}_H^2 - \overline{\overline{X}}_L^2)$$

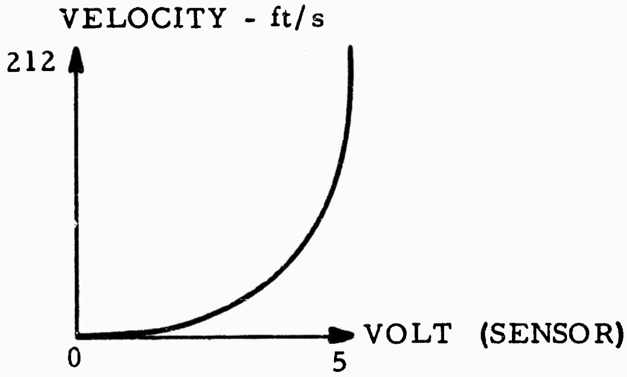
$$B = P_H 1/2 - M\overline{\overline{X}}_H 1/2$$

Where P_H = Physical value (ft/s) equivalent to high-calibration sensor voltage.

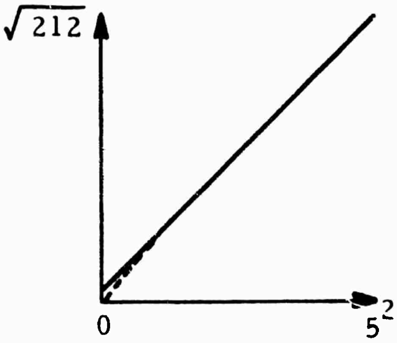
P_L = Physical value (ft/s) equivalent to low-calibration sensor voltage.

$\overline{\overline{X}}_H$ = CENDAR voltage representation (volts) of high-calibration sensor voltage.

$\overline{\overline{X}}_L$ = CENDAR voltage representation of low-calibration sensor voltage.

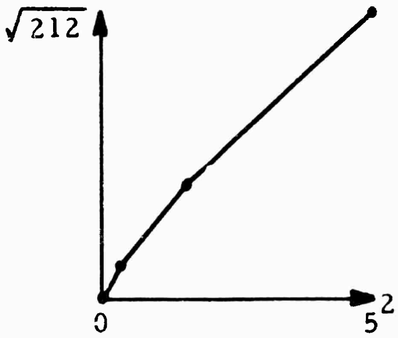


TRUE CALIBRATION CURVE



USED IN FOLLOWING PROGRAMS:
CII, CII M1, CII M2, CII M3, CII M3-1,
CII M3-1*, CII M3-1**, CII M5

LINEARIZED CALIBRATION CURVE



USED IN CII M6

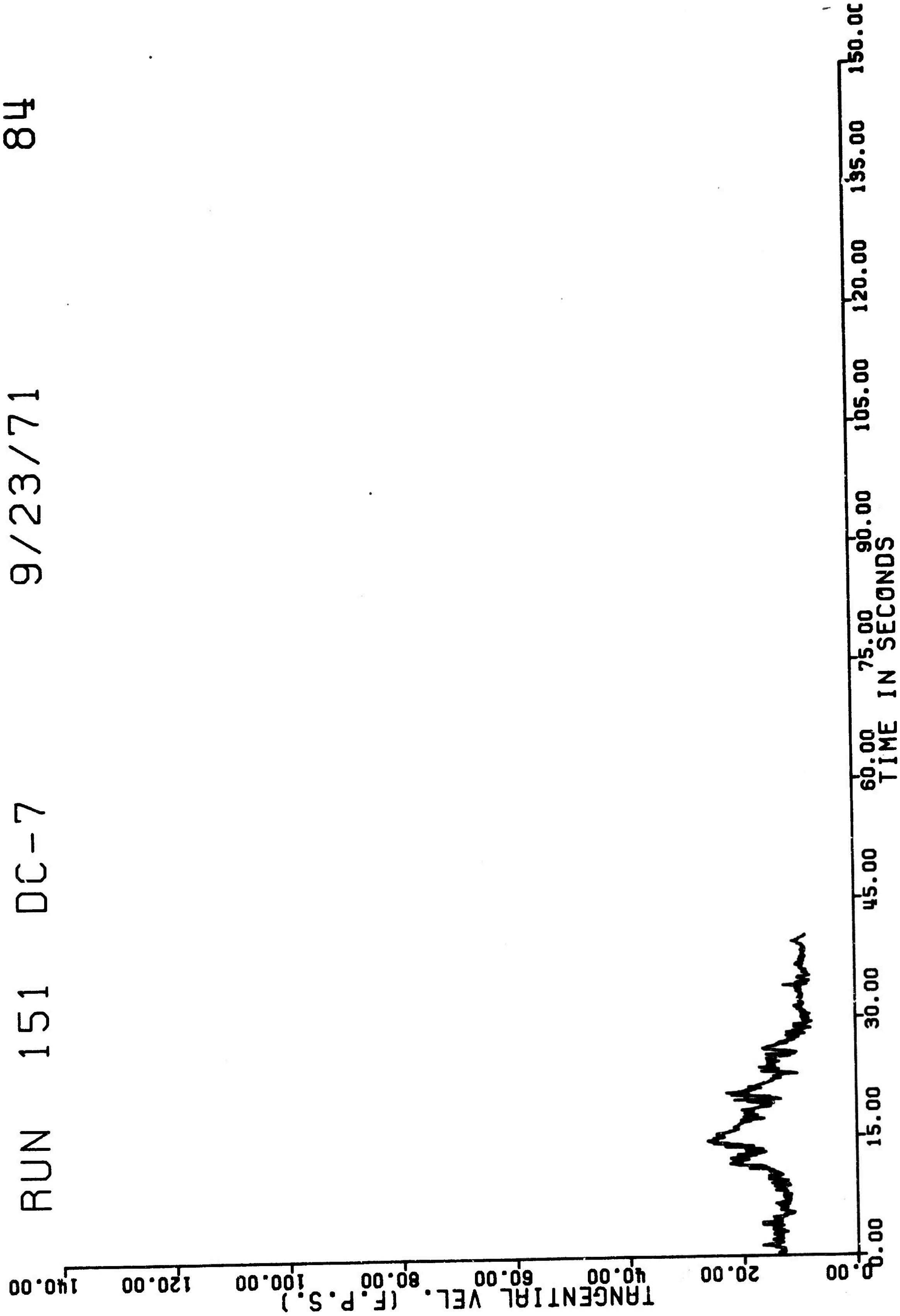
SEGMENTED LINEARIZED CALIBRATION CURVE

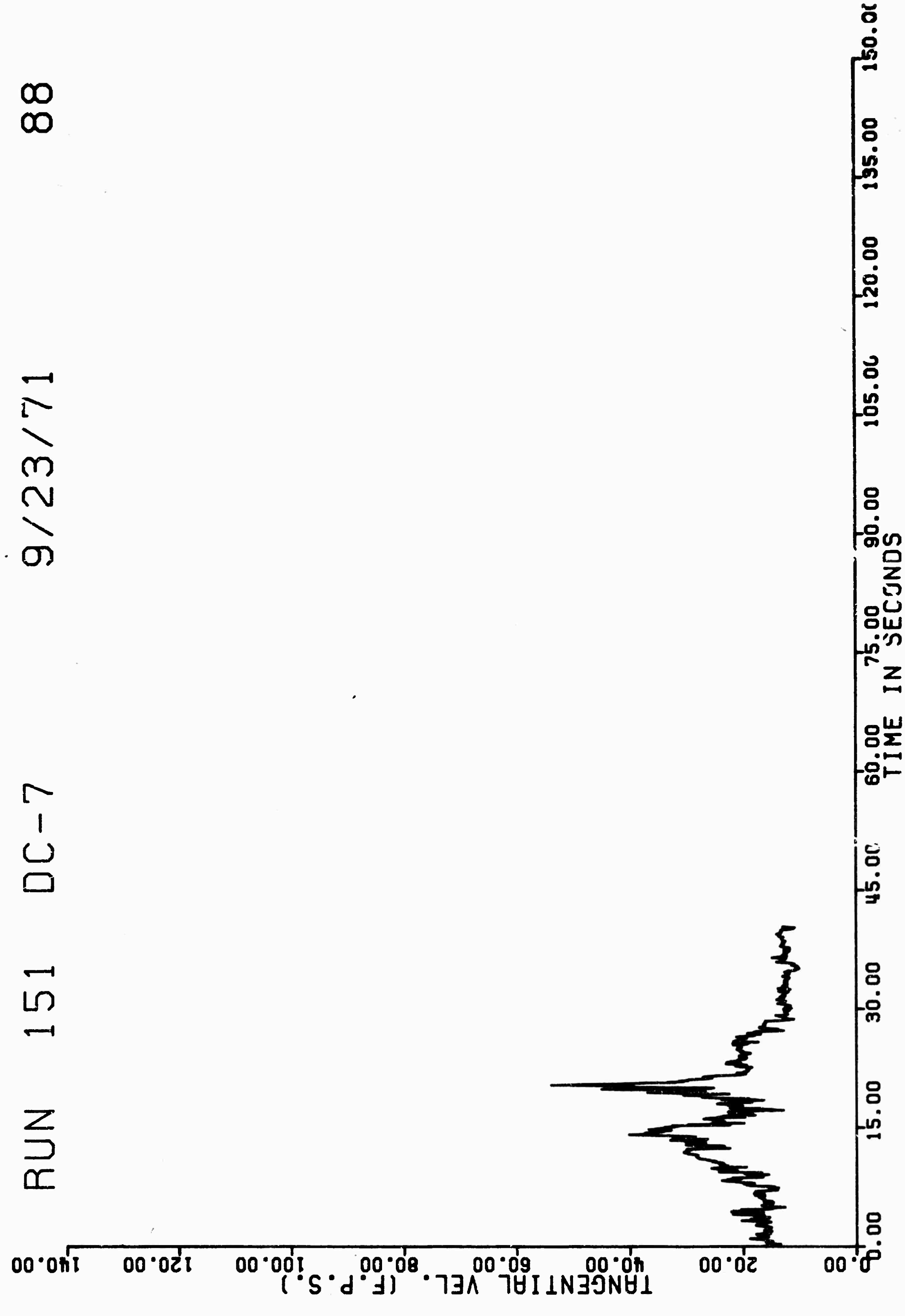
FIGURE C-4. SEGMENTED LINEARIZED CALIBRATION CURVE.

APPENDIX D

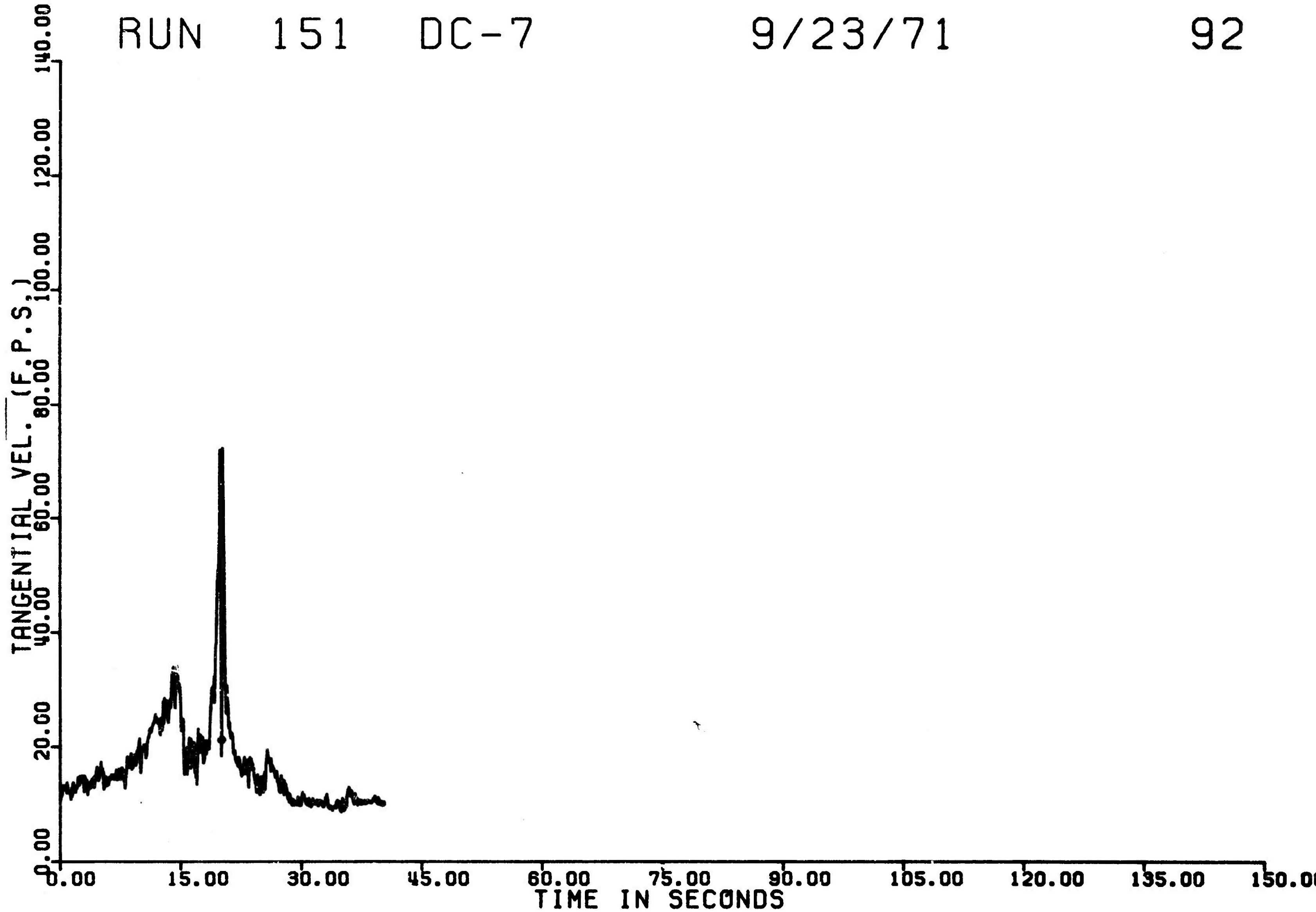
RUN 151, TANGENTIAL VELOCITY

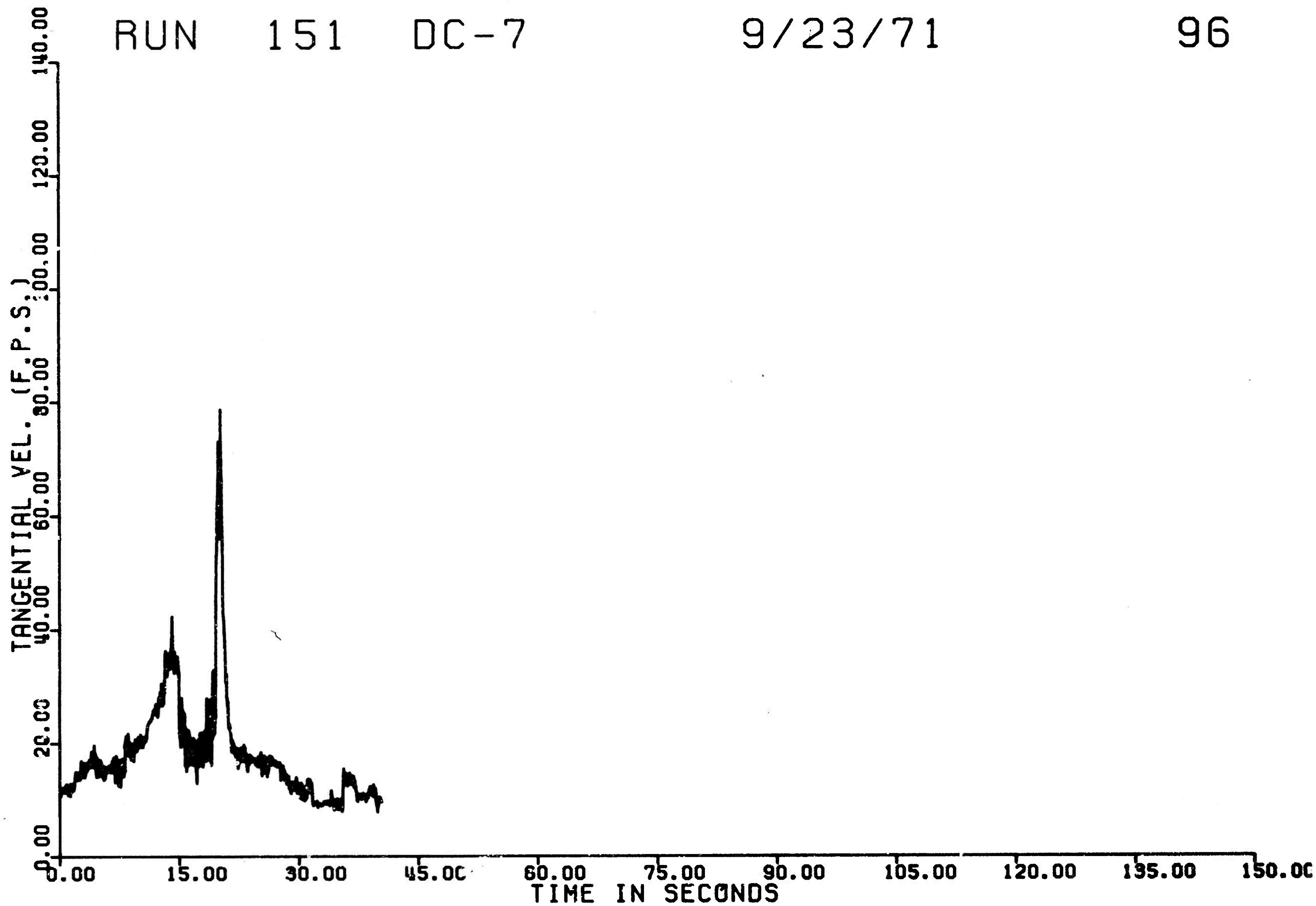
VERSUS TIME RECORDS

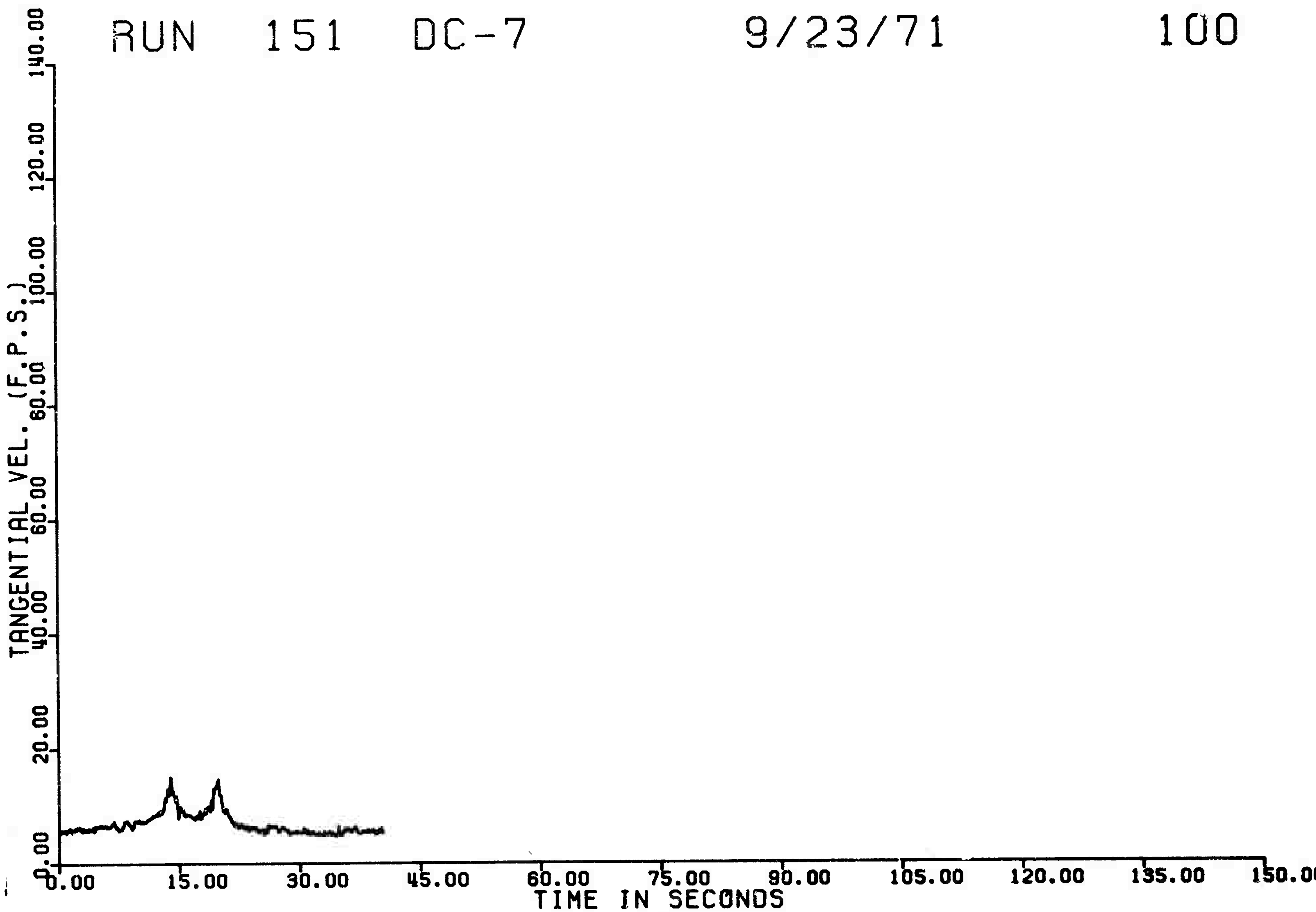

RUN 151 DC-7 9/23/71 84
TIME IN SECONDS
0.00 15.00 30.00 45.00 60.00 75.00 90.00 105.00 120.00 135.00 150.00
TANGENTIAL VEL. (F.P.S.)
0.00 20.00 40.00 60.00 80.00 100.00 120.00 140.00



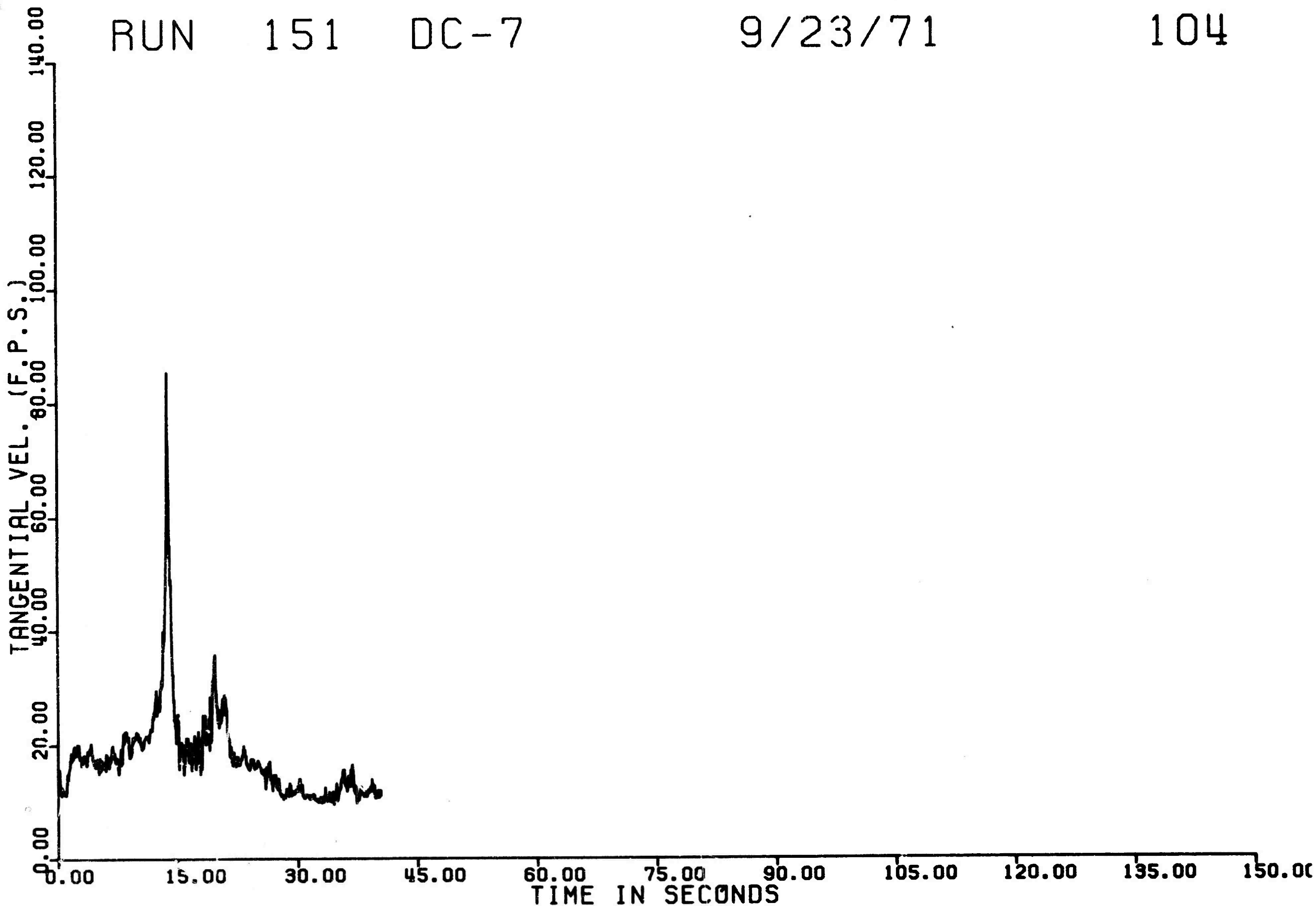
RUN 151 DC-7 9/23/71 88
TANGENTIAL VEL. (F.P.S.)
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
TIME IN SECONDS
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
135.00
150.00

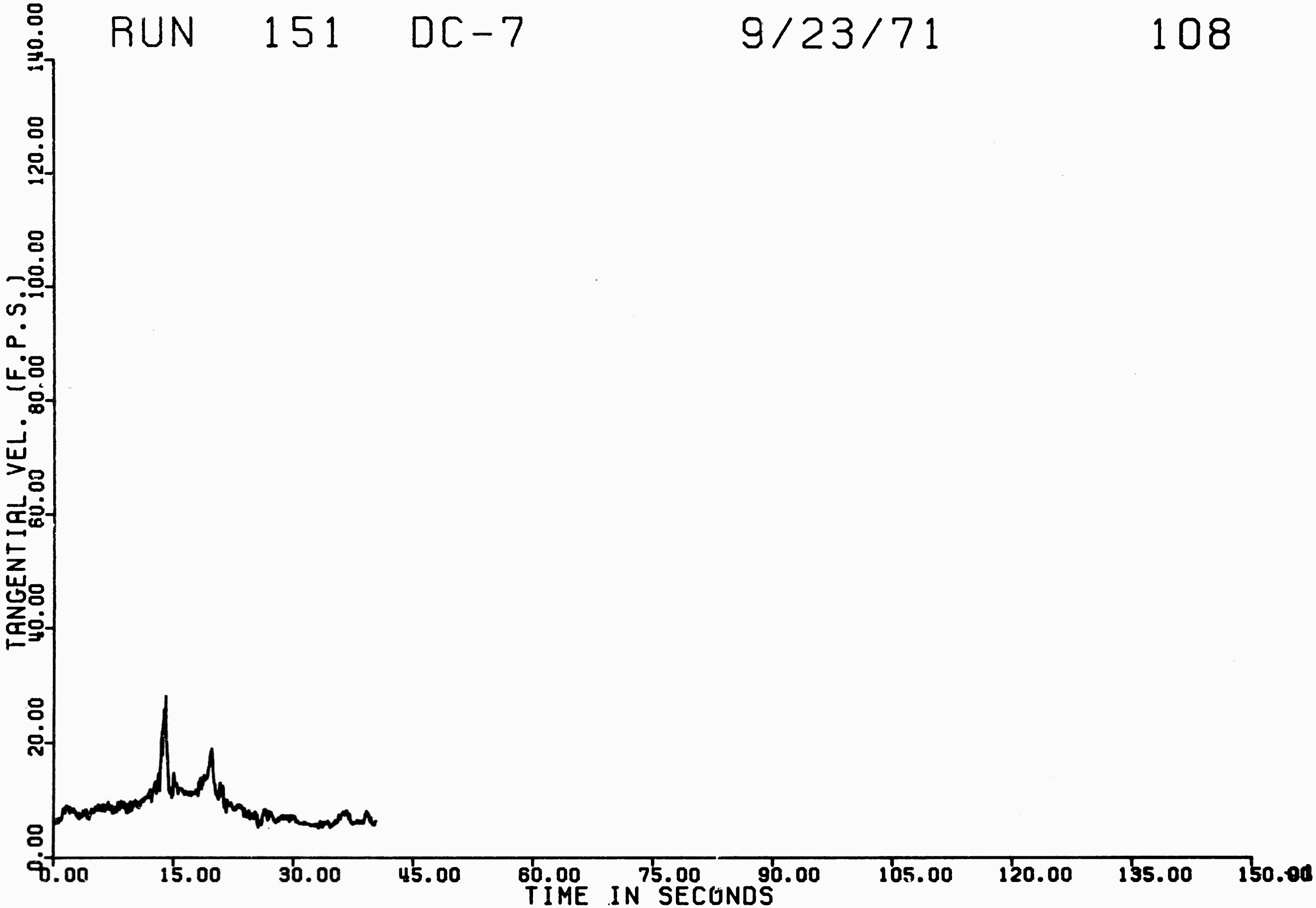

RUN 151 DC-7
9/23/71
92
TANGENTIAL VEL. (F.P.S.)
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
TIME IN SECONDS
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
135.00
150.00


RUN 151 DC-7 9/23/71 96
TANGENTIAL VEL. (F.P.S.)
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
135.00
150.00
TIME IN SECONDS

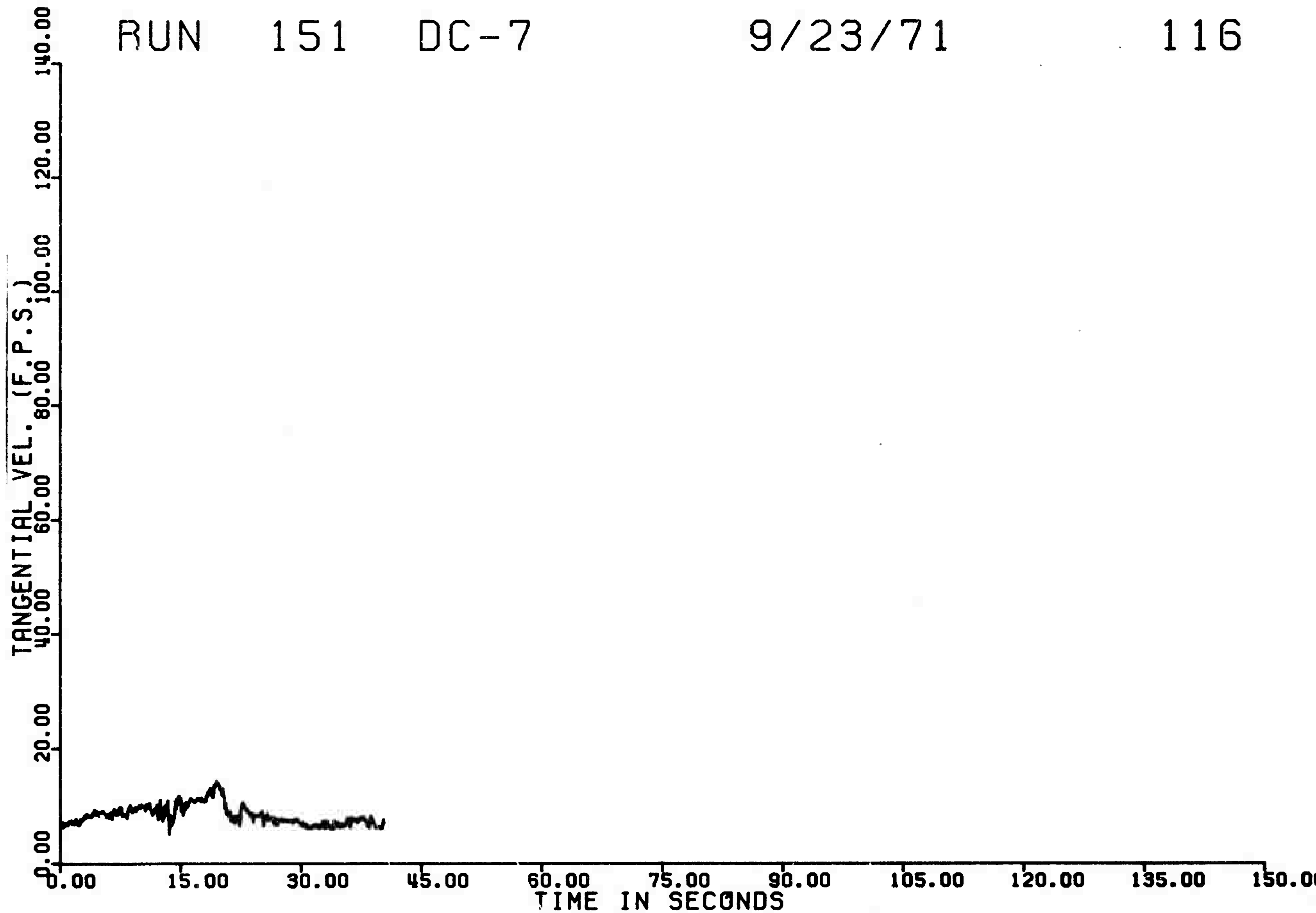


RUN 151 DC-7 9/23/71 100
TANGENTIAL VEL. (F.P.S.)
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
135.00
150.00
TIME IN SECONDS


RUN 151 DC-7
9/23/71
104
TANGENTIAL VEL. (F.P.S.)
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
135.00
150.00
TIME IN SECONDS


RUN 151 DC-7 9/23/71 108
TANGENTIAL VEL. (F.P.S.)
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
135.00
150.00
TIME IN SECONDS

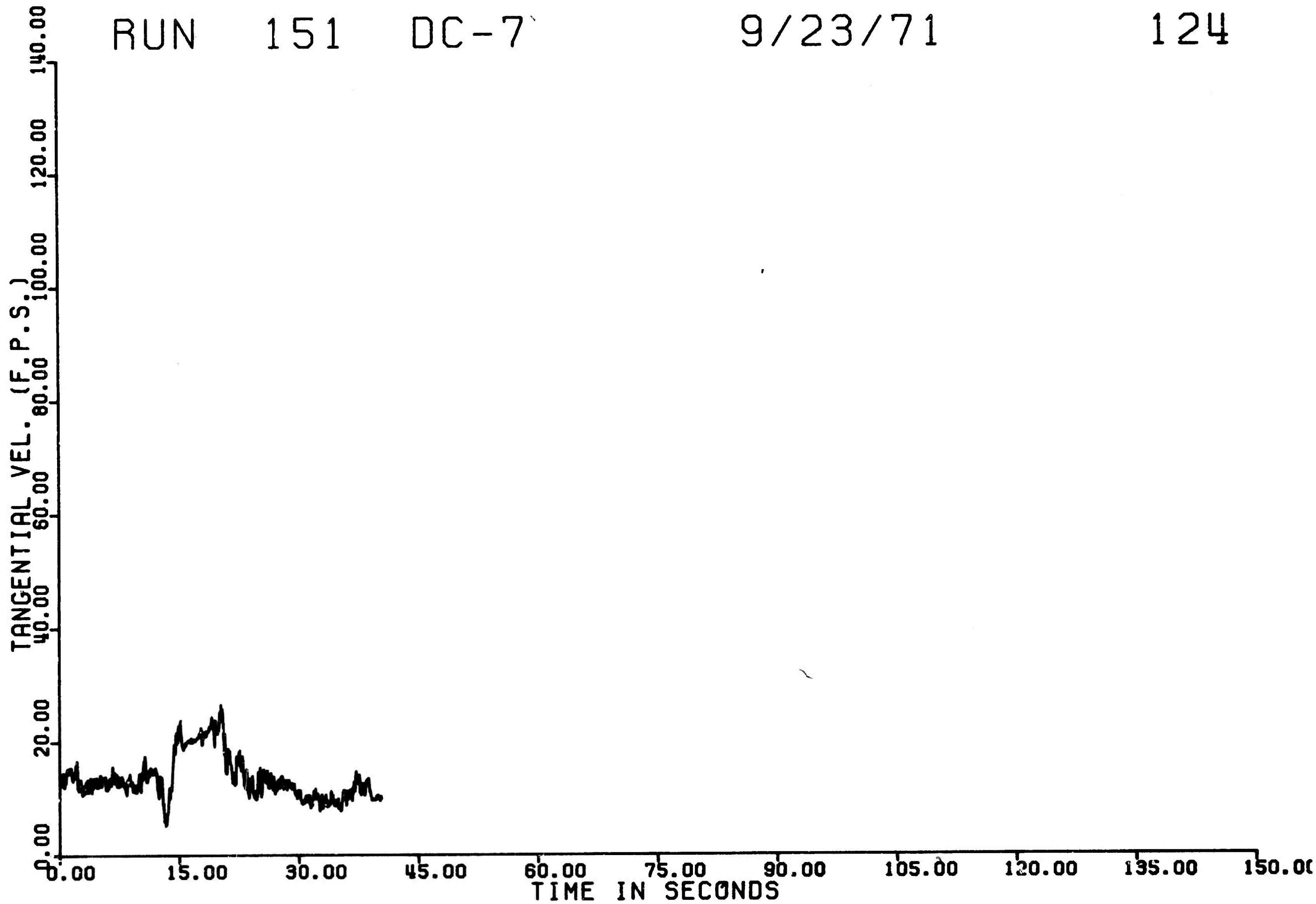

RUN 151 DC-7 9/23/71 112
TANGENTIAL VEL. (F.P.S.)
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
135.00
150.00
TIME IN SECONDS

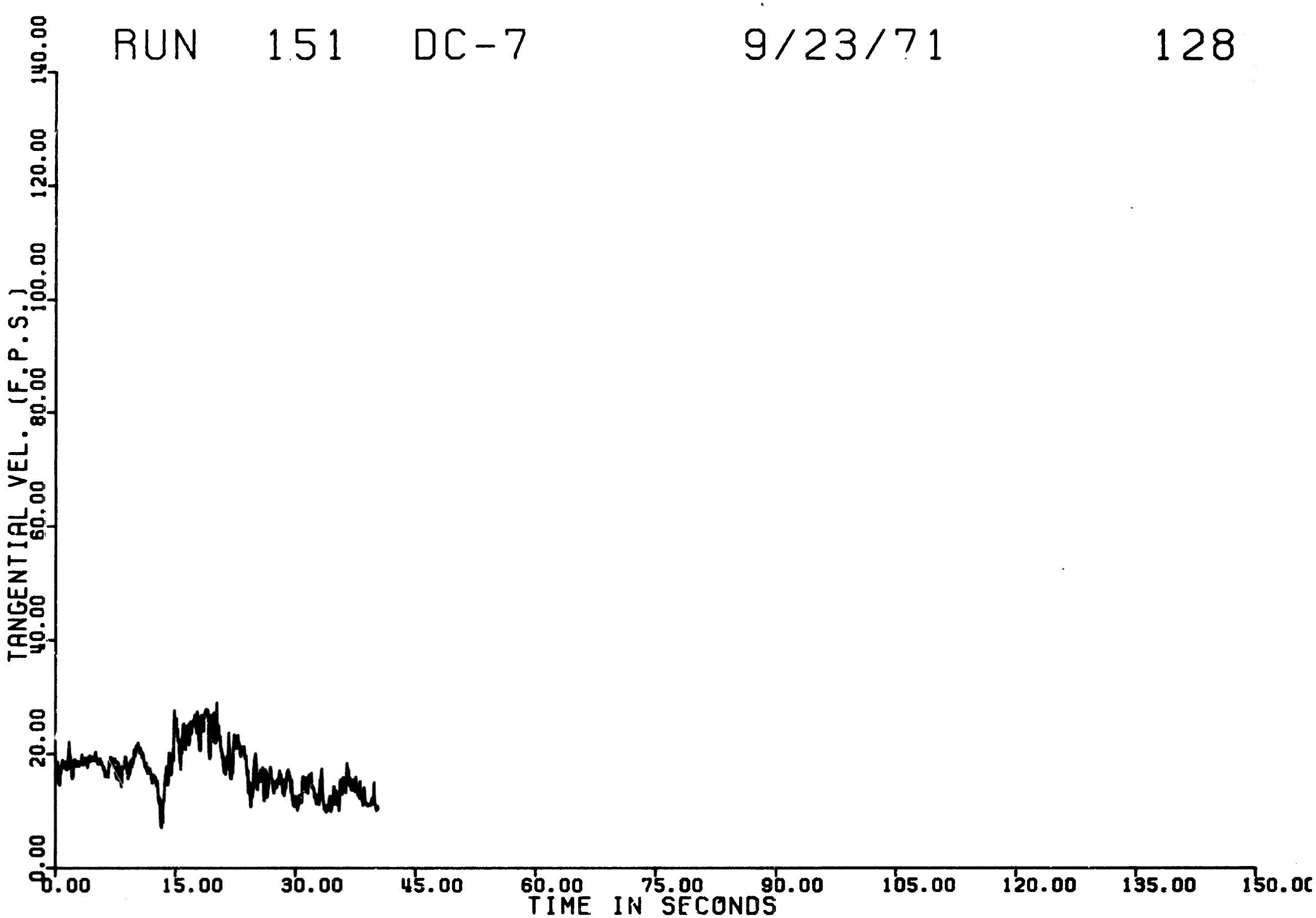


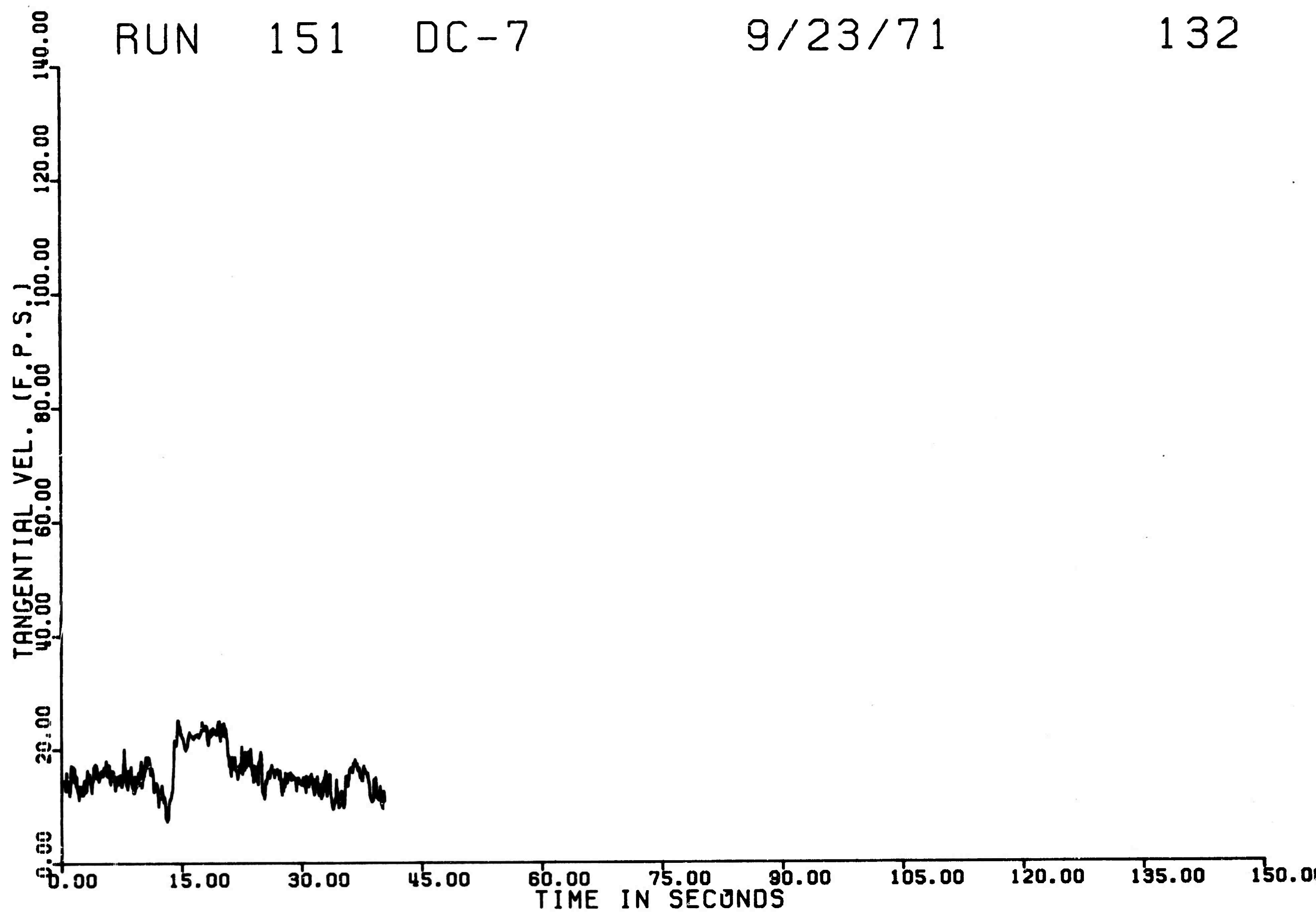
RUN 151 DC-7 9/23/71 116
TANGENTIAL VEL. (F.P.S.)
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
0.00 15.00 30.00 45.00 60.00 75.00 90.00 105.00 120.00 135.00 150.00
TIME IN SECONDS

RUN 151 DC-7 9/23/71 120

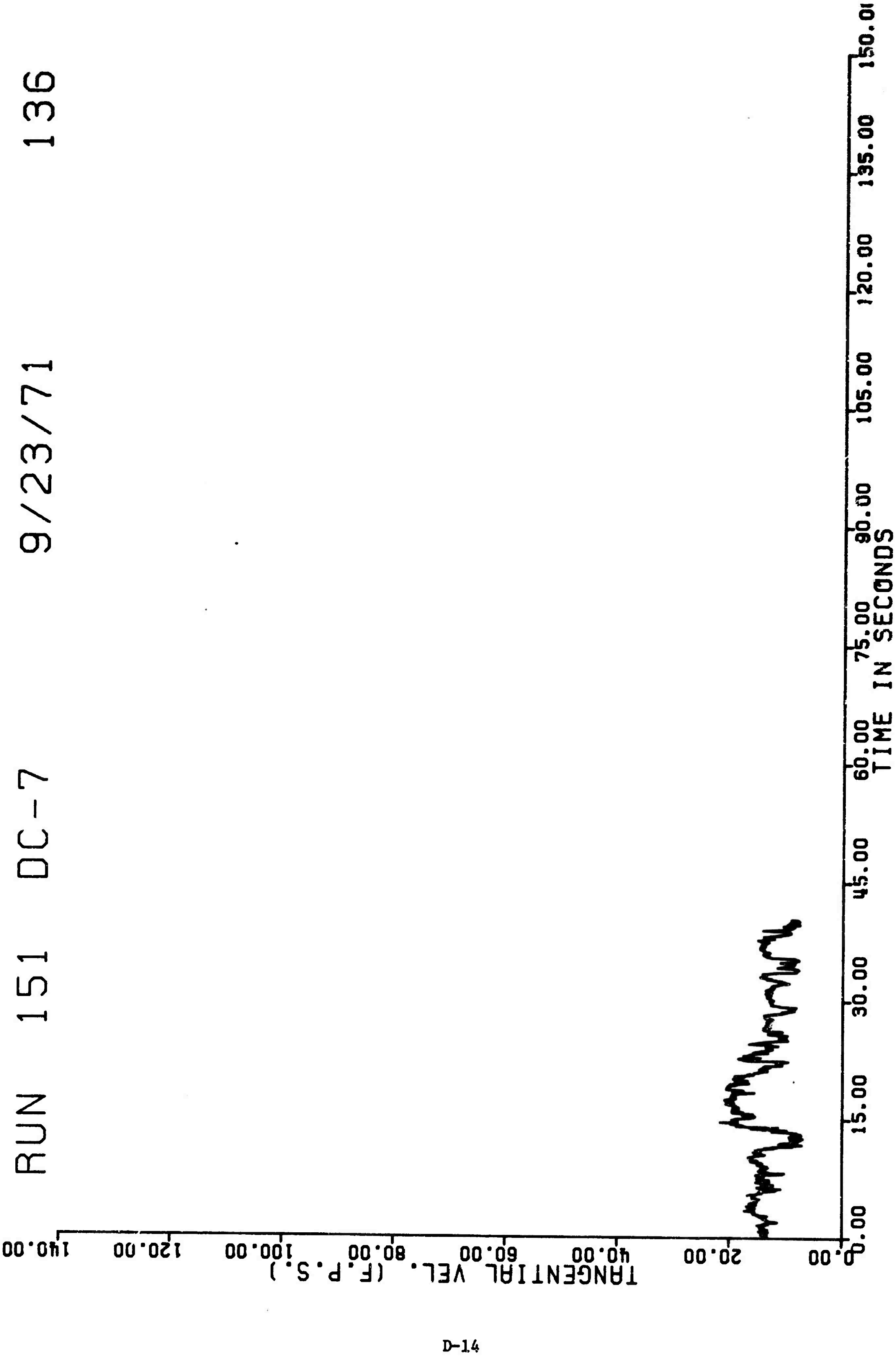
RUN 151 DC-7 9/23/71 124




RUN 151 DC-7 9/23/71 128
TANGENTIAL VEL. (F.P.S.)
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
135.00
150.00
TIME IN SECONDS

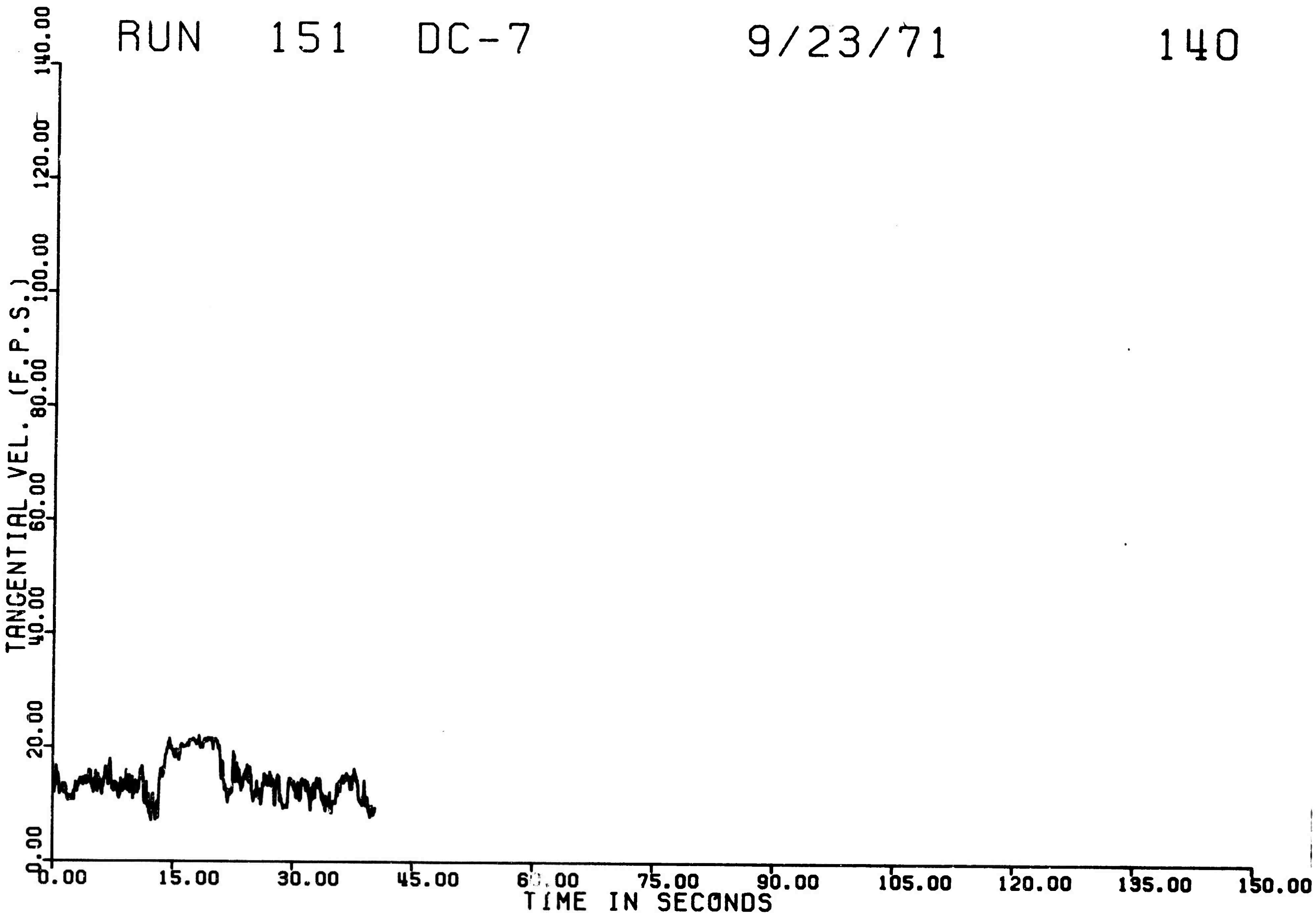


RUN 151 DC-7 9/23/71 132
TANGENTIAL VEL. (F.P.S.)
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
TIME IN SECONDS
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
135.00
150.00



RUN 151 DC-7 9/23/71 136
TANGENTIAL VEL. (F.P.S.)
0.00
20.00
40.00
60.00
80.00
100.00
120.00
140.00
TIME IN SECONDS
0.00
15.00
30.00
45.00
60.00
75.00
90.00
105.00
120.00
135.00
150.00

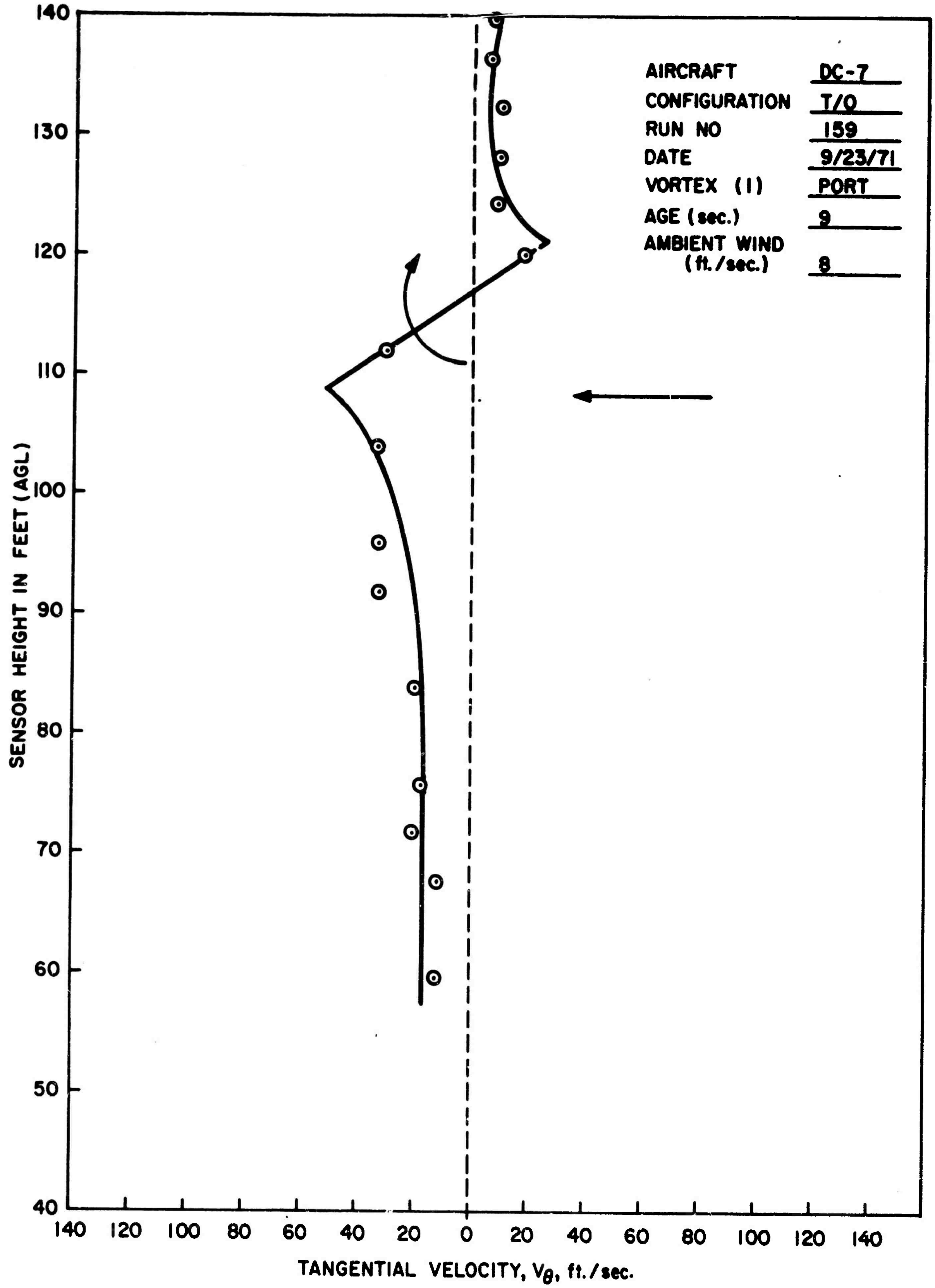
RUN 151 DC-7 9/23/71 140



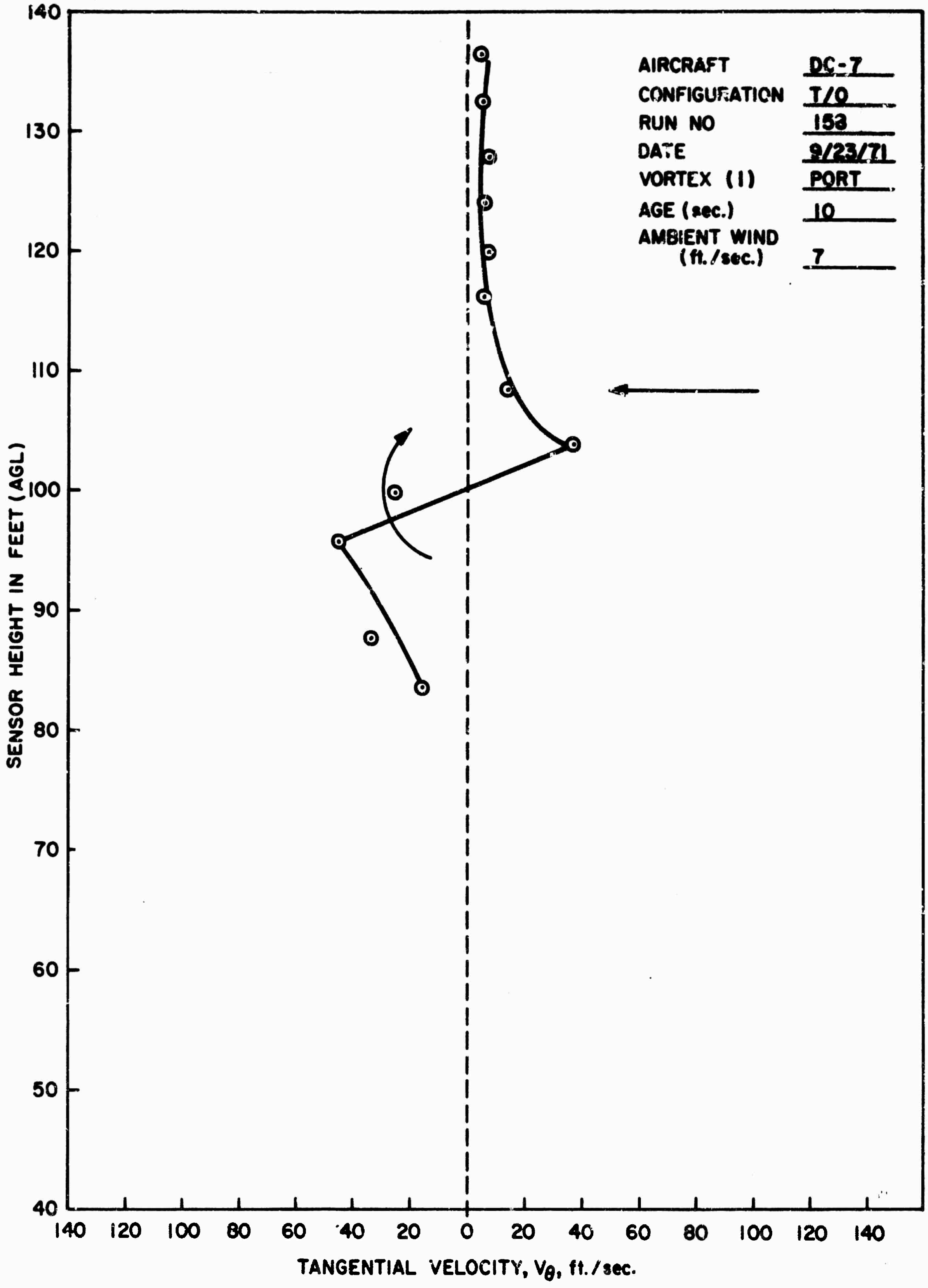
APPENDIX E

VORTEX TANGENTIAL VELOCITY

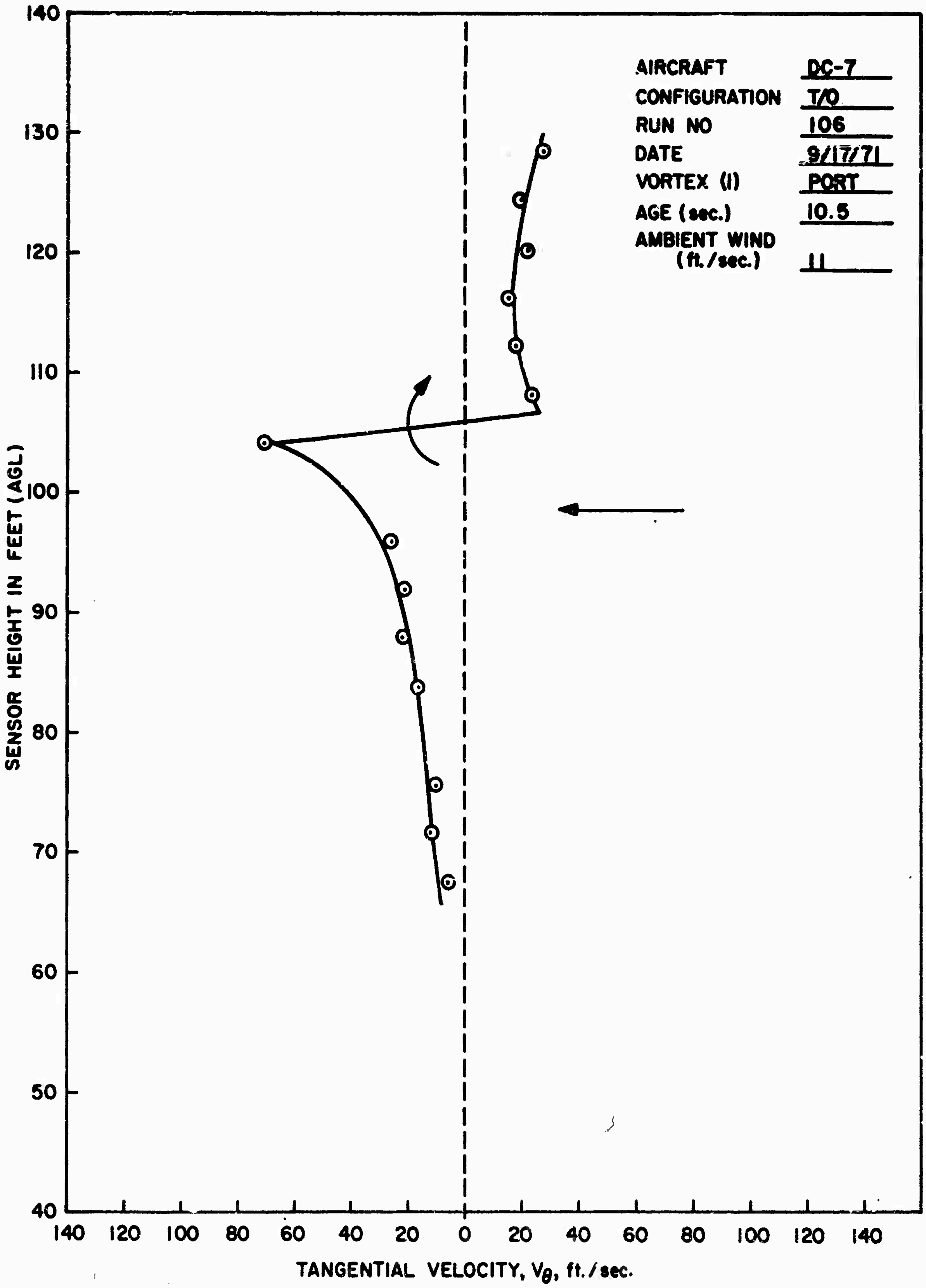
DISTRIBUTION PLOTS (V_θ vs h)



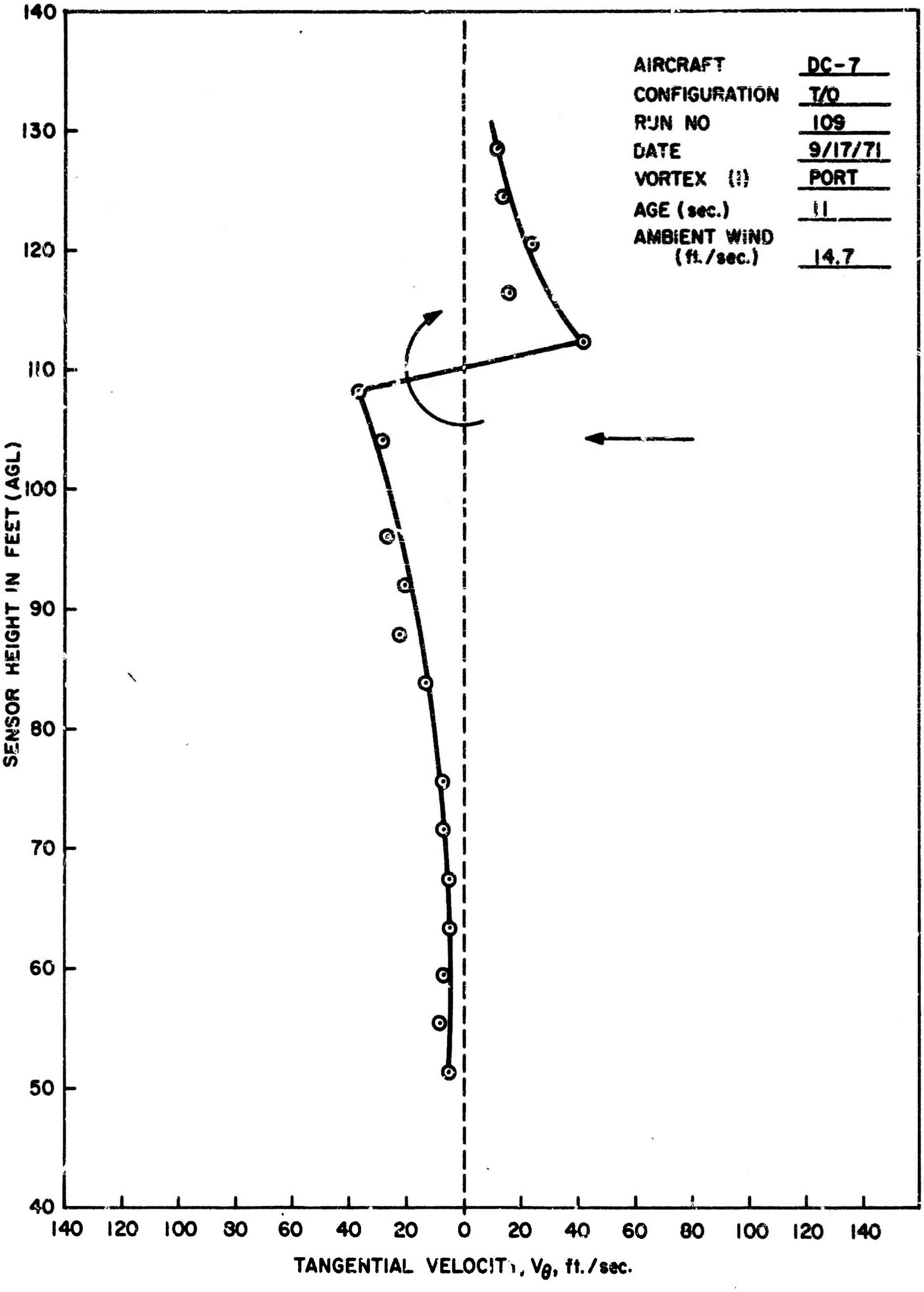
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 159
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 9
AMBIENT WIND (ft./sec.) 8
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.



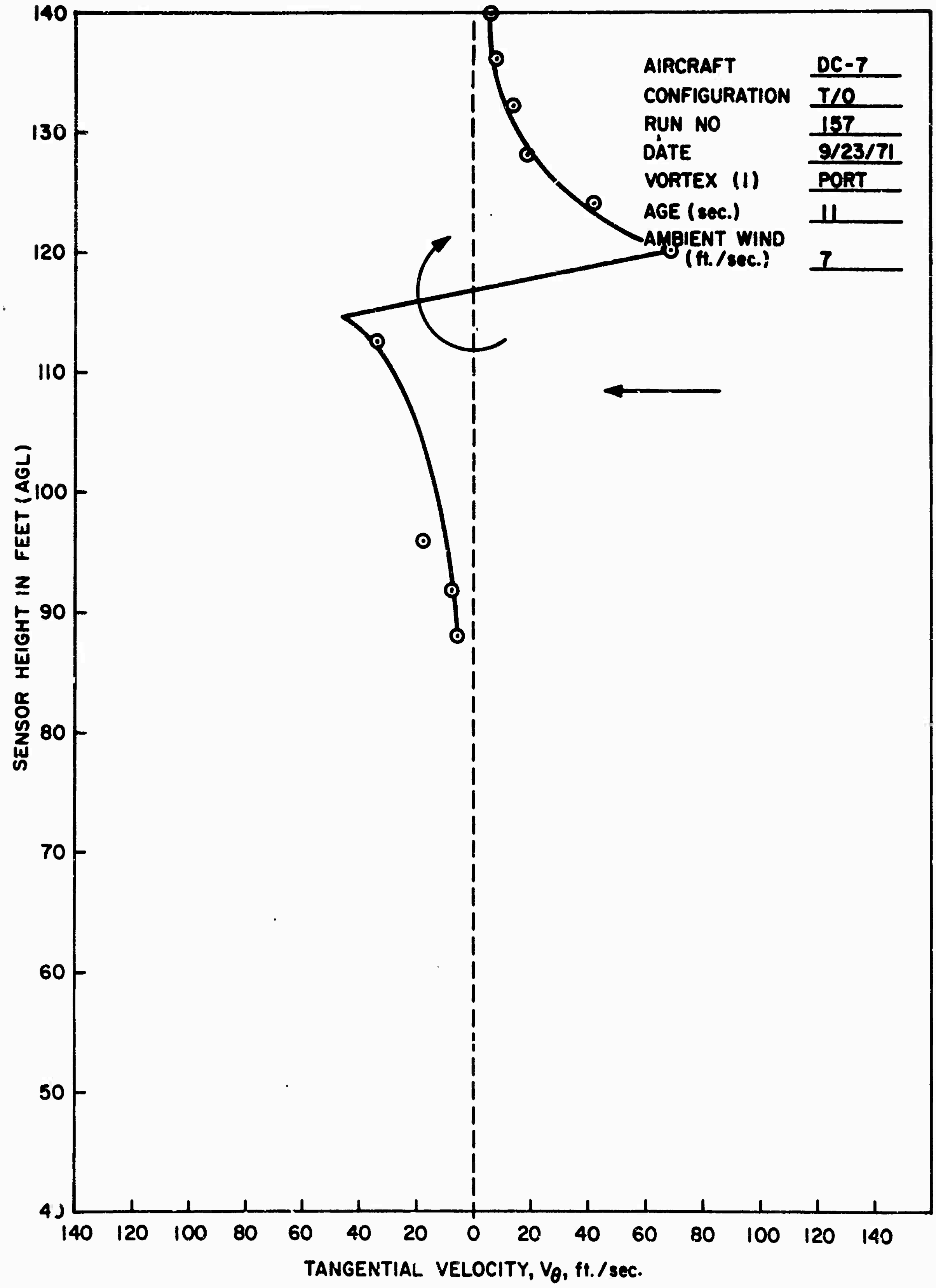
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 153
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 10
AMBIENT WIND (ft./sec.) 7
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

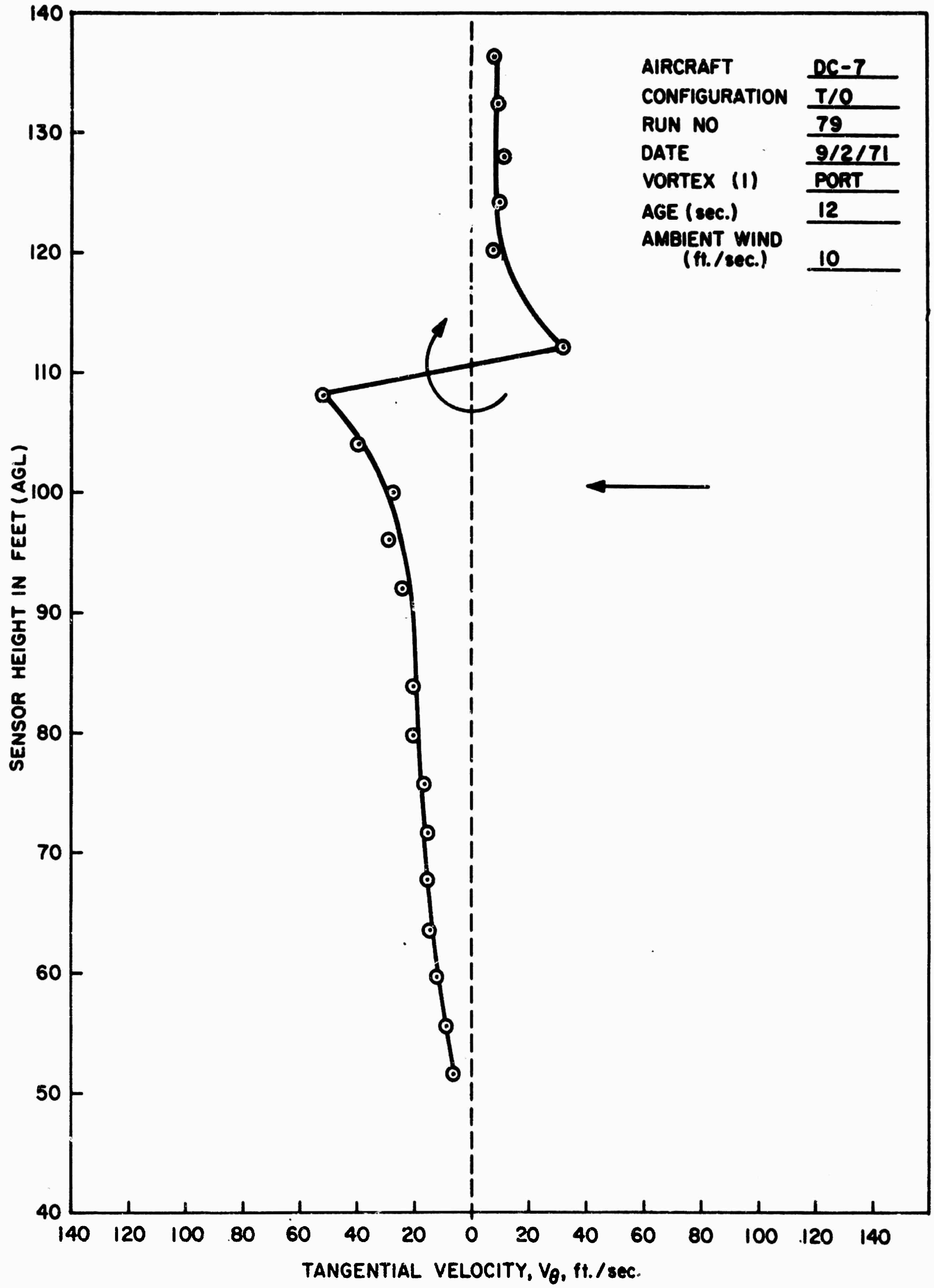


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 106
DATE 9/17/71
VORTEX (1) PORT
AGE (sec.) 10.5
AMBIENT WIND (ft./sec.) 11
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

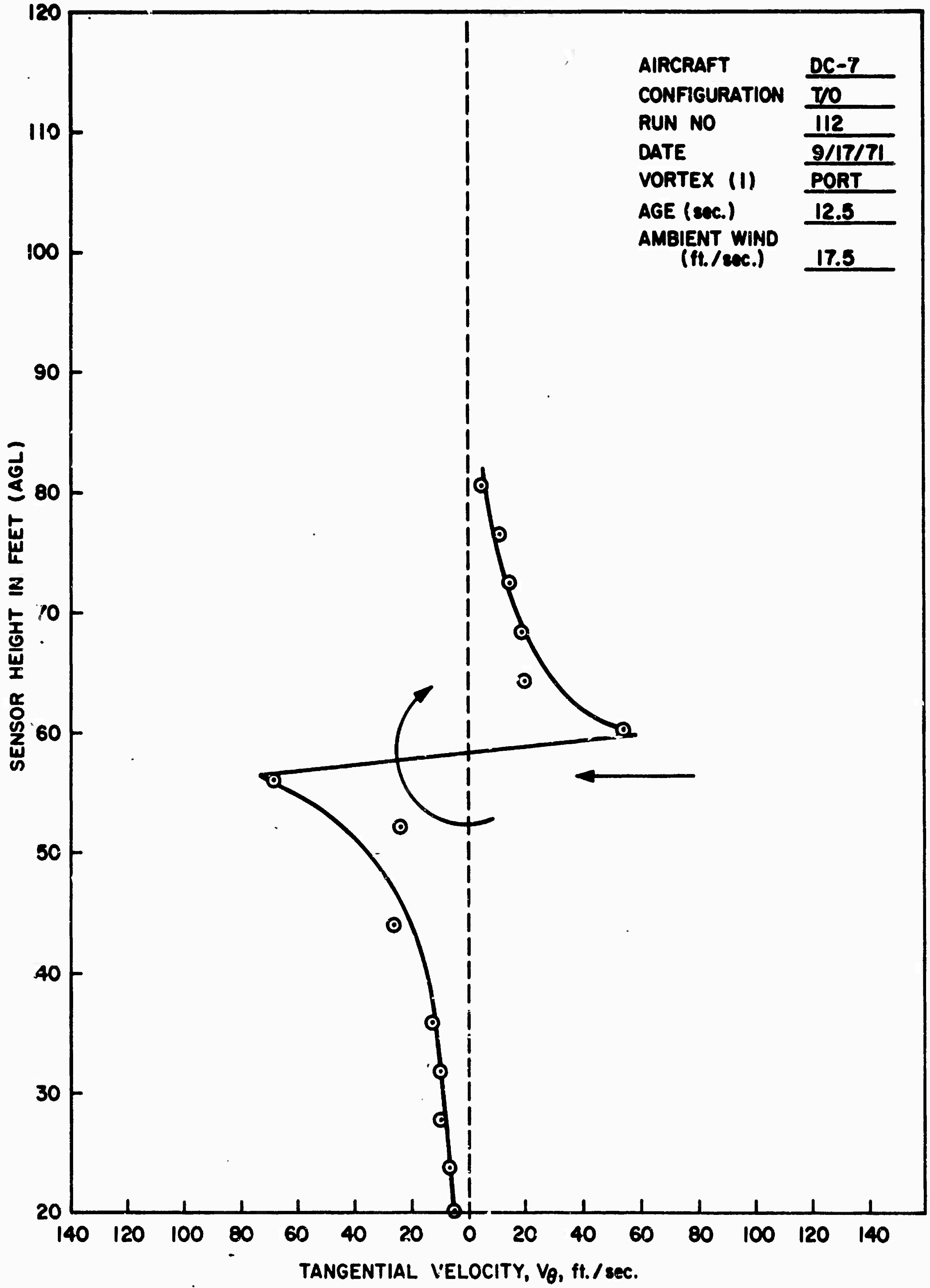


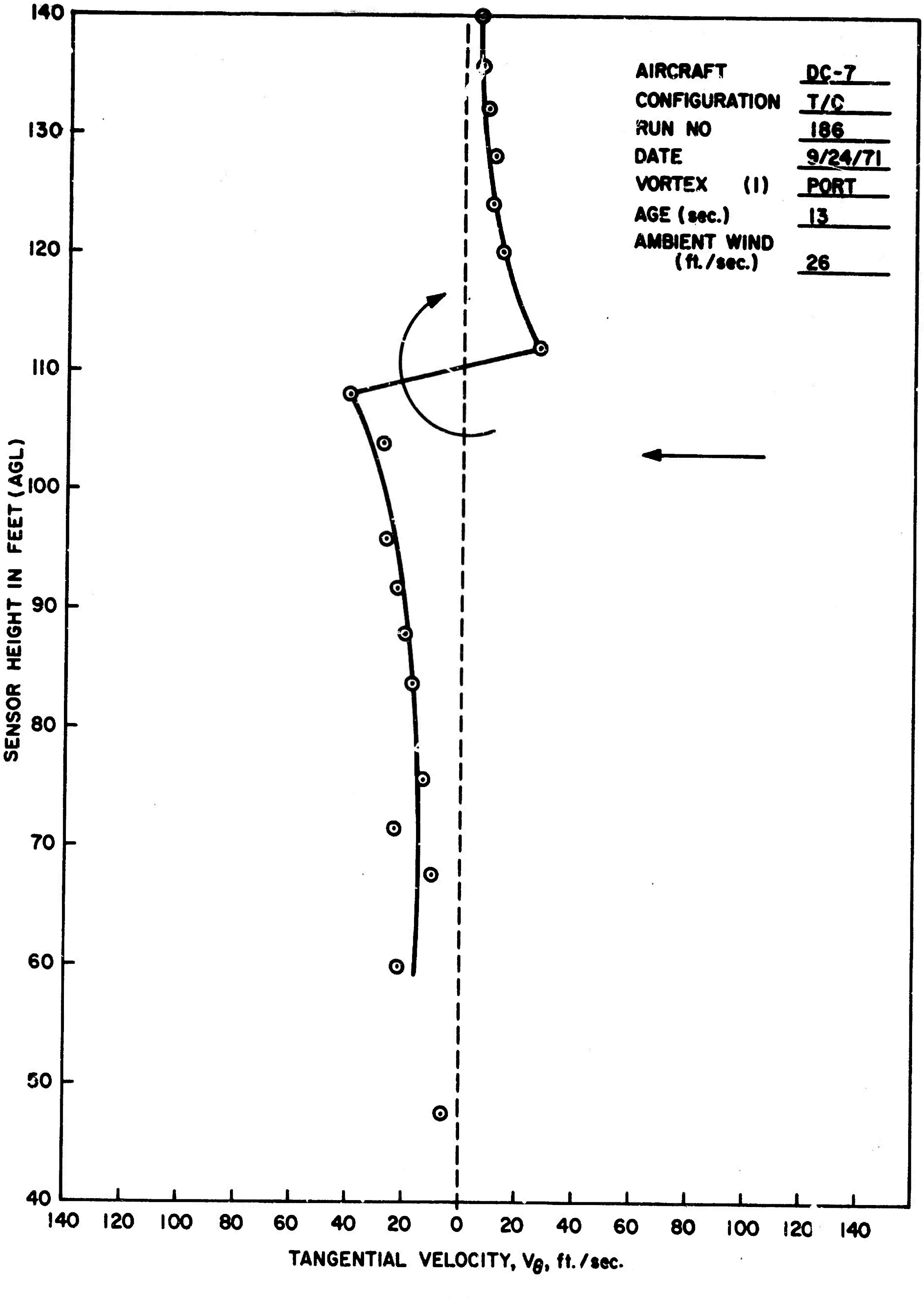
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 109
DATE 9/17/71
VORTEX (1) PORT
AGE (sec.) 11
AMBIENT WIND (ft./sec.) 14.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

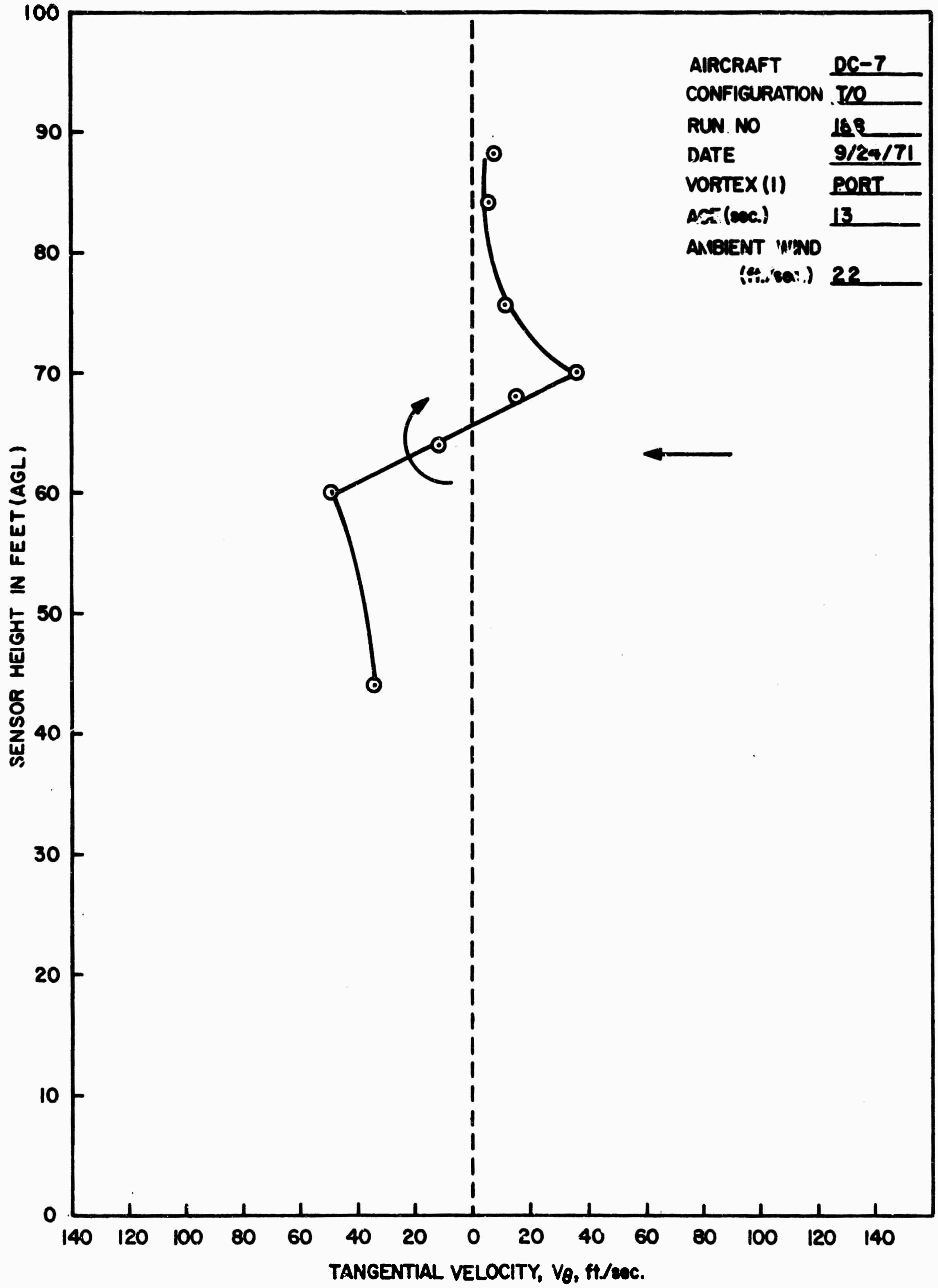

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 157
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 11
AMBIENT WIND (ft./sec.) 7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



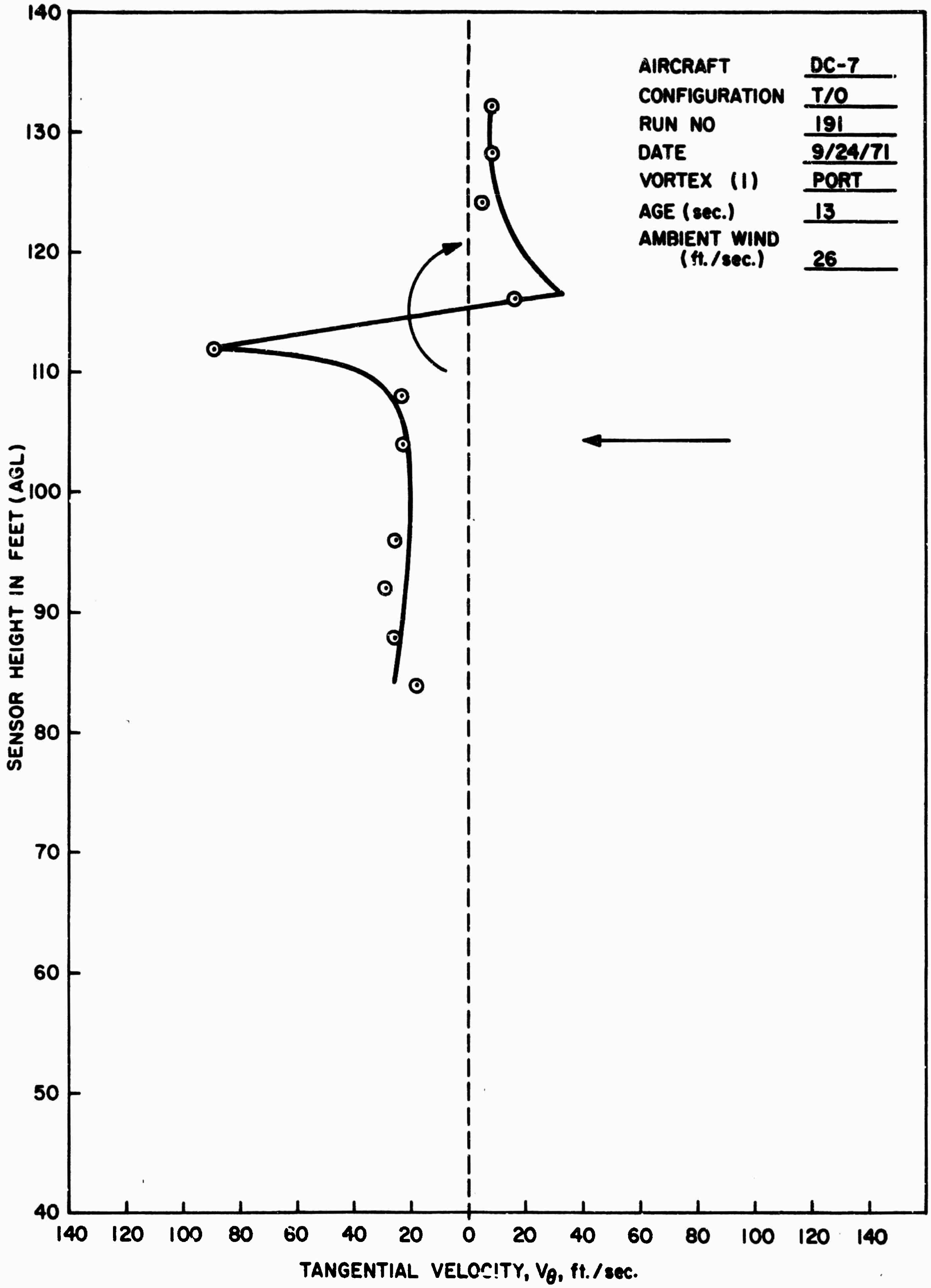
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 79
DATE 9/2/71
VORTEX (1) PORT
AGE (sec.) 12
AMBIENT WIND (ft./sec.) 10
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

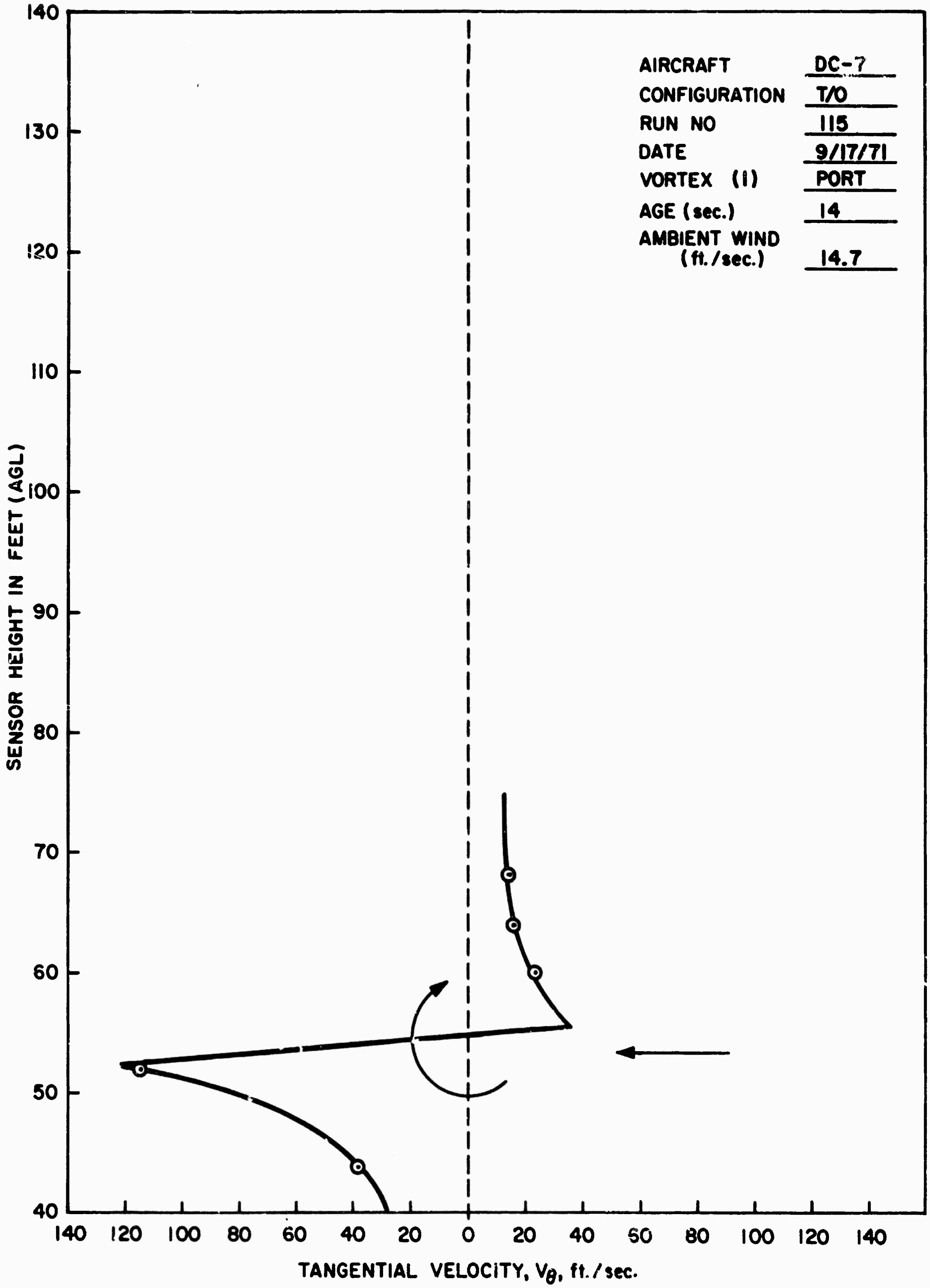

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 112
DATE 9/17/71
VORTEX (1) PORT
AGE (sec.) 12.5
AMBIENT WIND (ft./sec.) 17.5
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
120
110
100
90
80
70
60
50
40
30
20
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

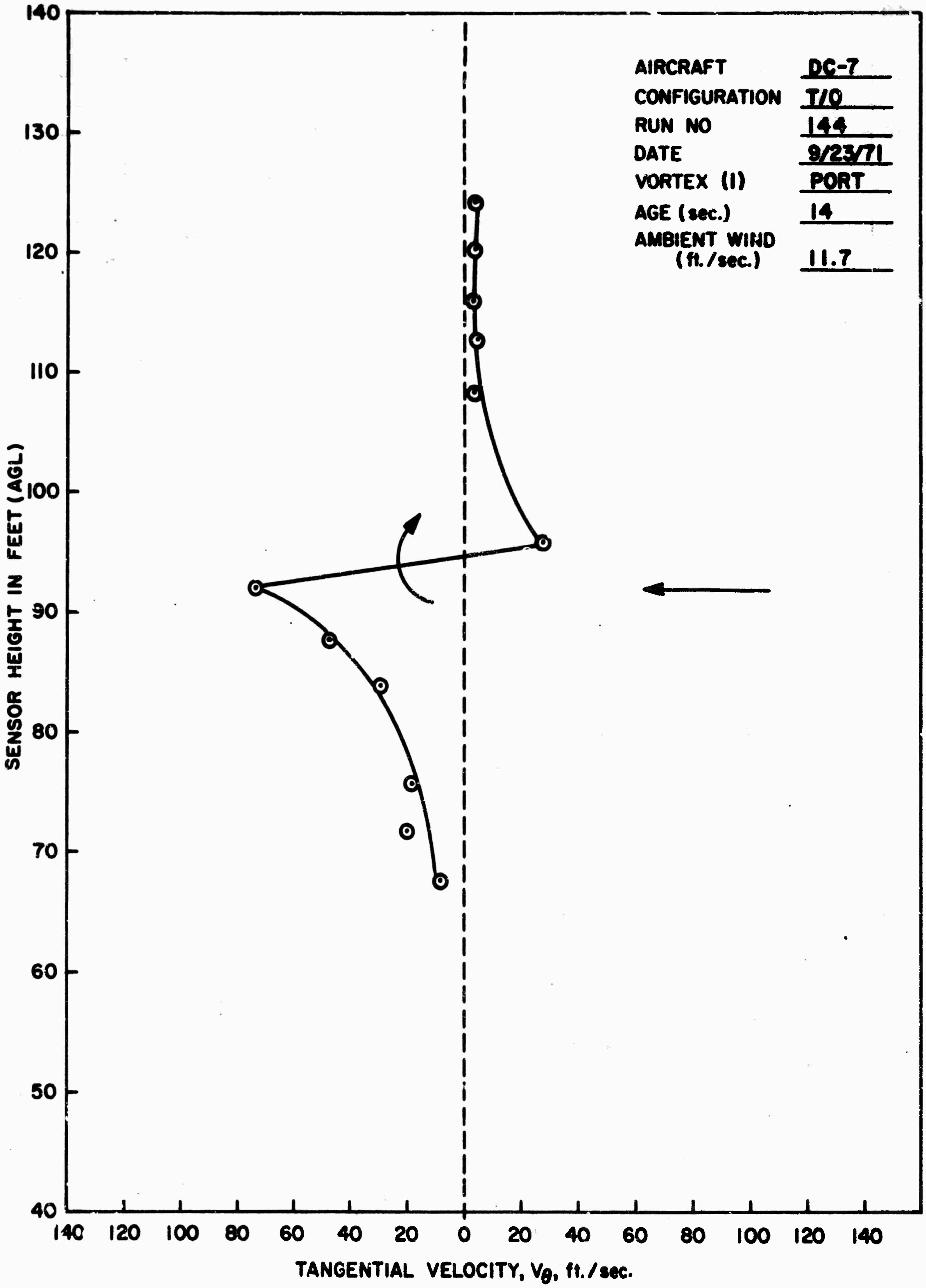

AIRCRAFT DC-7
CONFIGURATION T/C
RUN NO 186
DATE 9/24/71
VORTEX (1) PORT
AGE (sec.) 13
AMBIENT WIND (ft./sec.) 26
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140



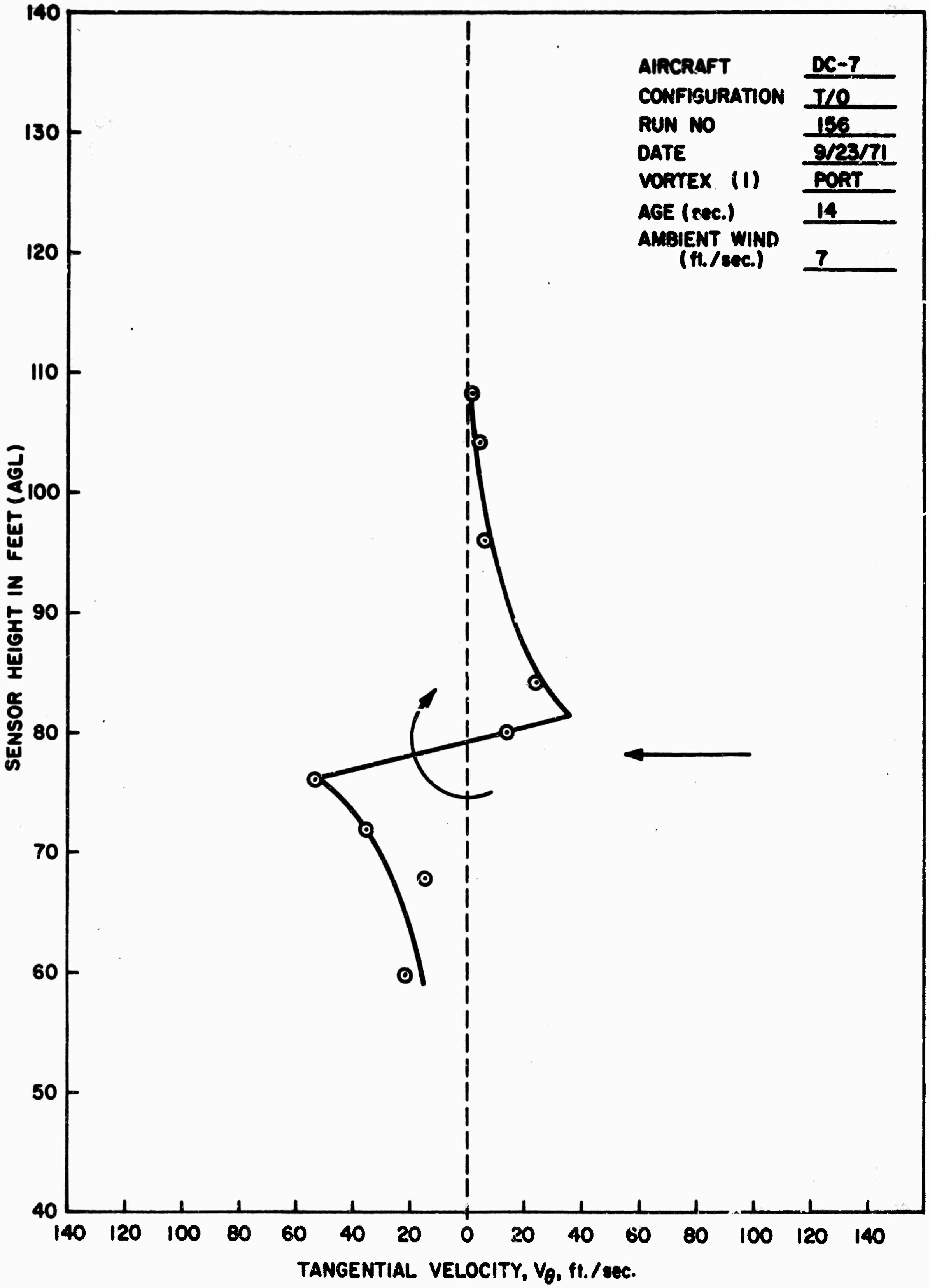
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 168
DATE 9/24/71
VORTEX (1) PORT
AGE (sec.) 13
AMBIENT WIND (ft./sec.) 22
SENSOR HEIGHT IN FEET (AGL)
100
90
80
70
60
50
40
30
20
10
0
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

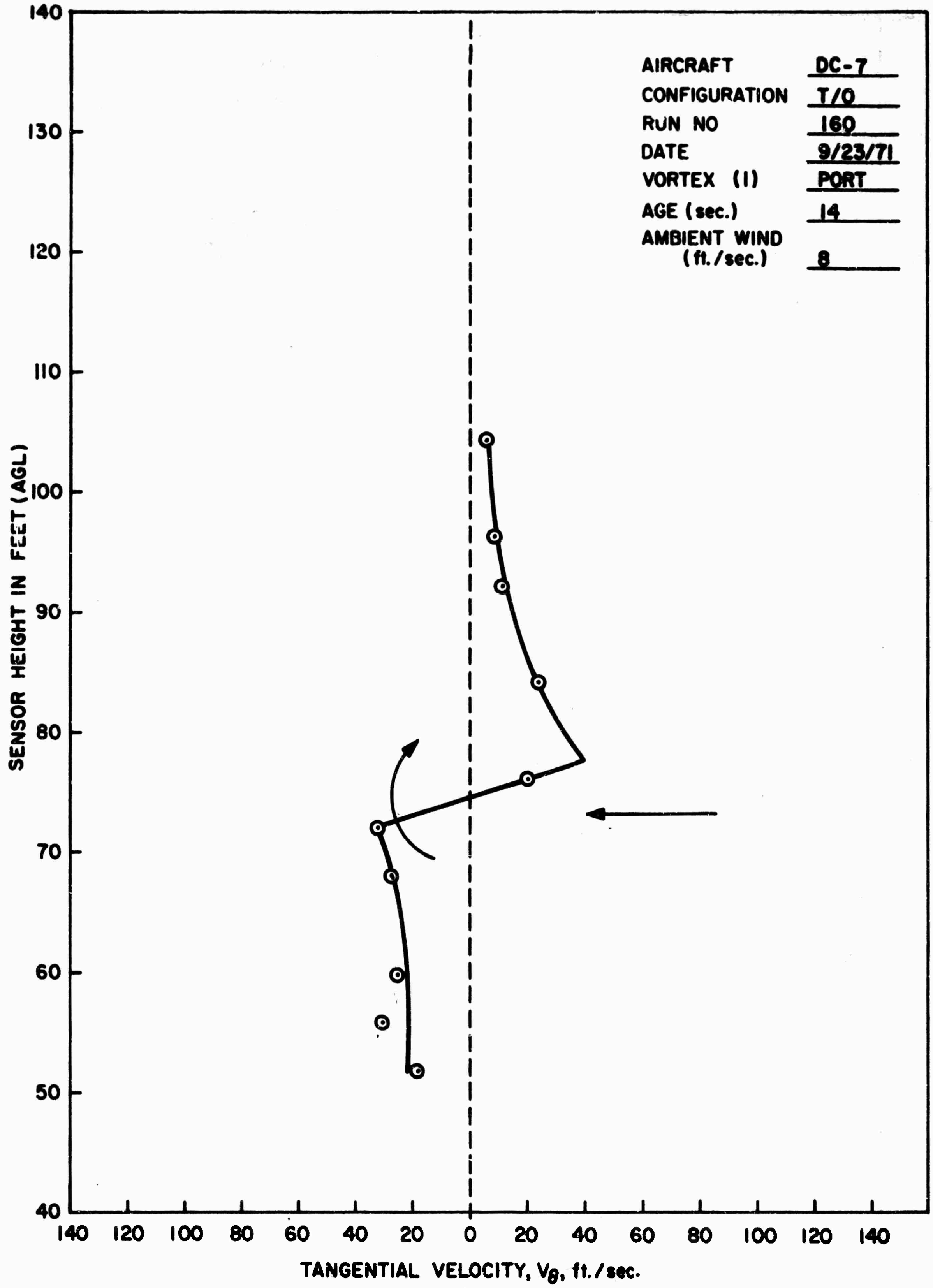

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 191
DATE 9/24/71
VORTEX (1) PORT
AGE (sec.) 13
AMBIENT WIND (ft./sec.) 26
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

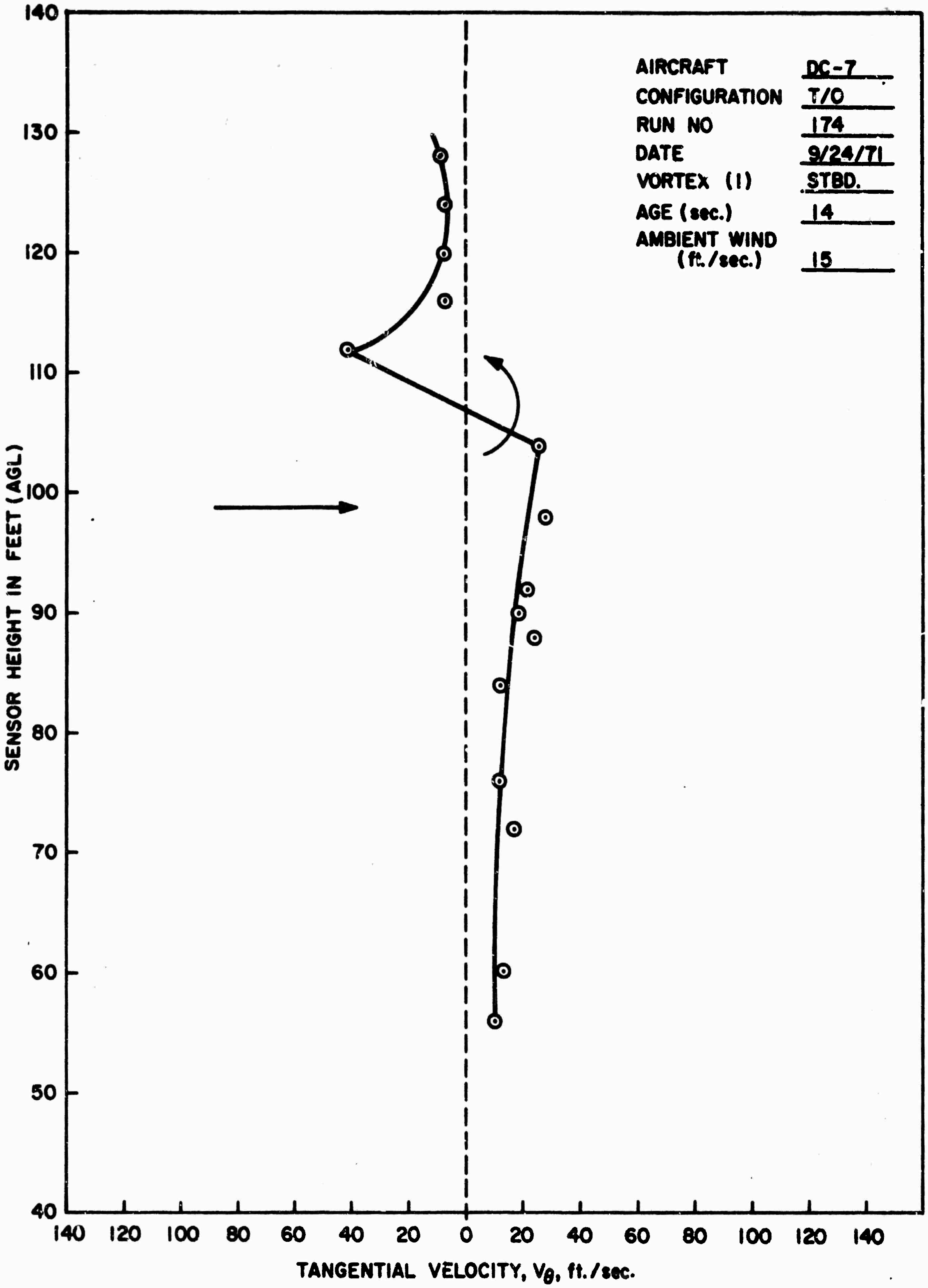

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 115
DATE 9/17/71
VORTEX (1) PORT
AGE (sec.) 14
AMBIENT WIND (ft./sec.) 14.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

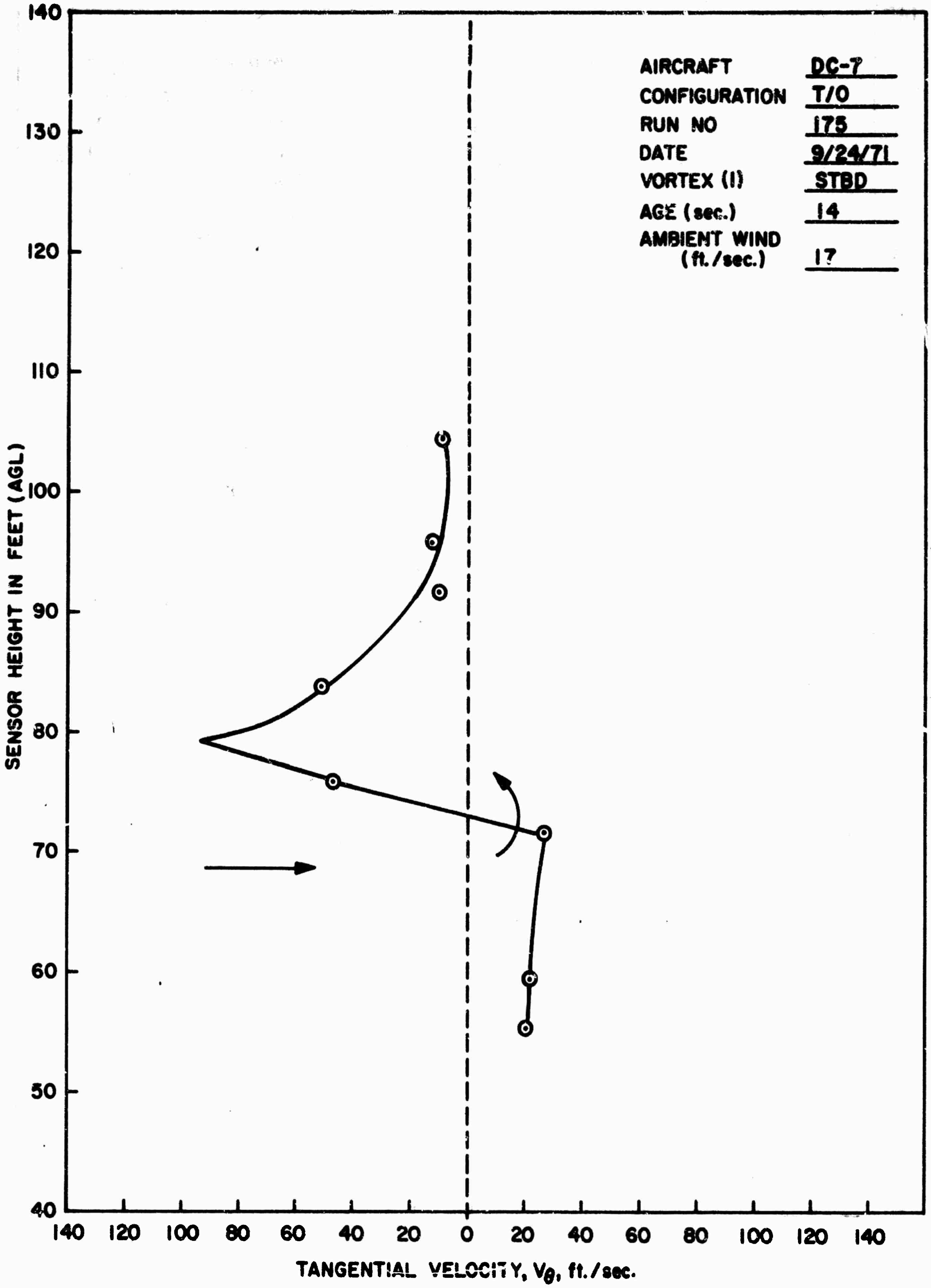


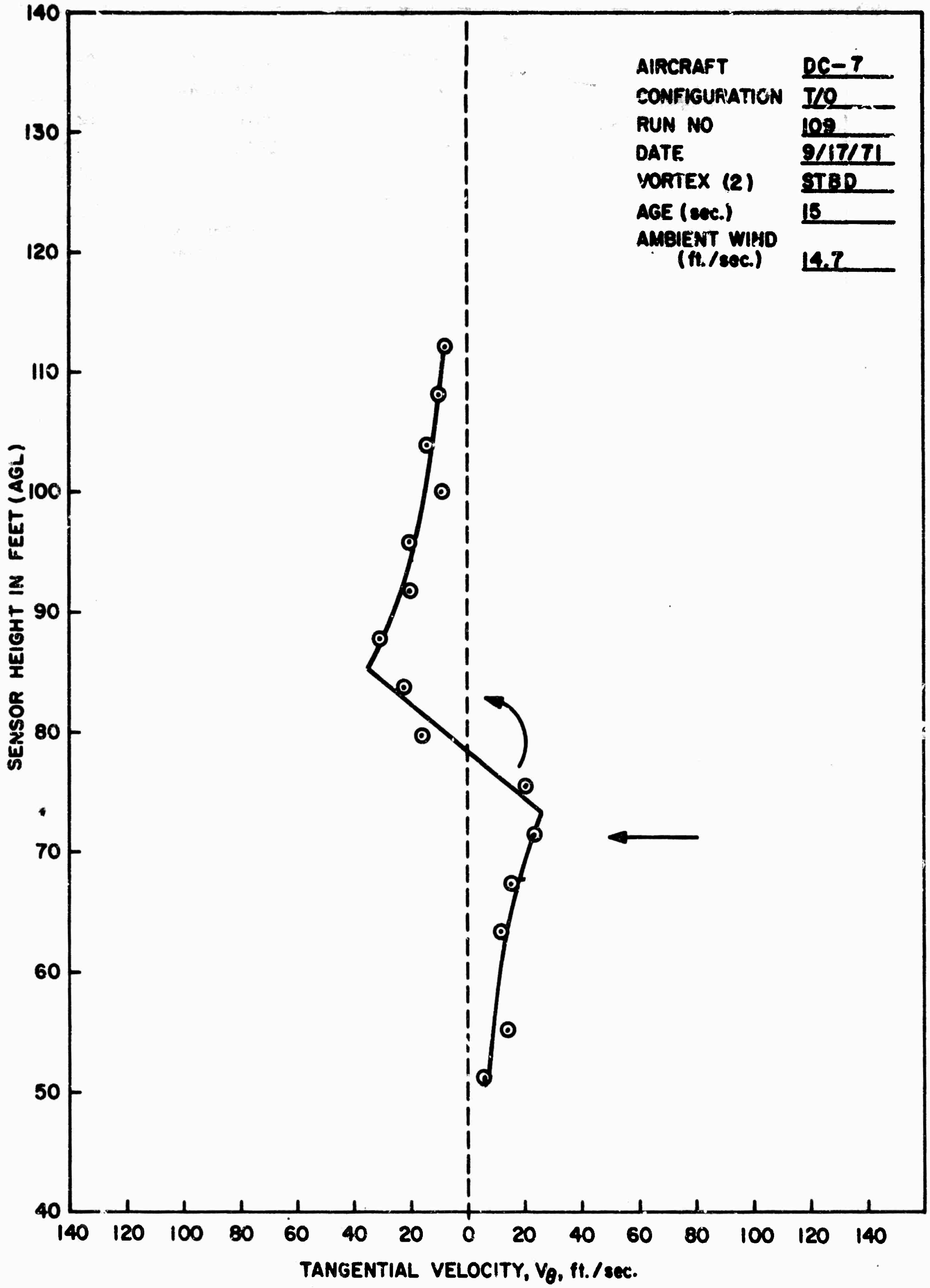
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 144
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 14
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 156
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 14
AMBIENT WIND (ft./sec.) 7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

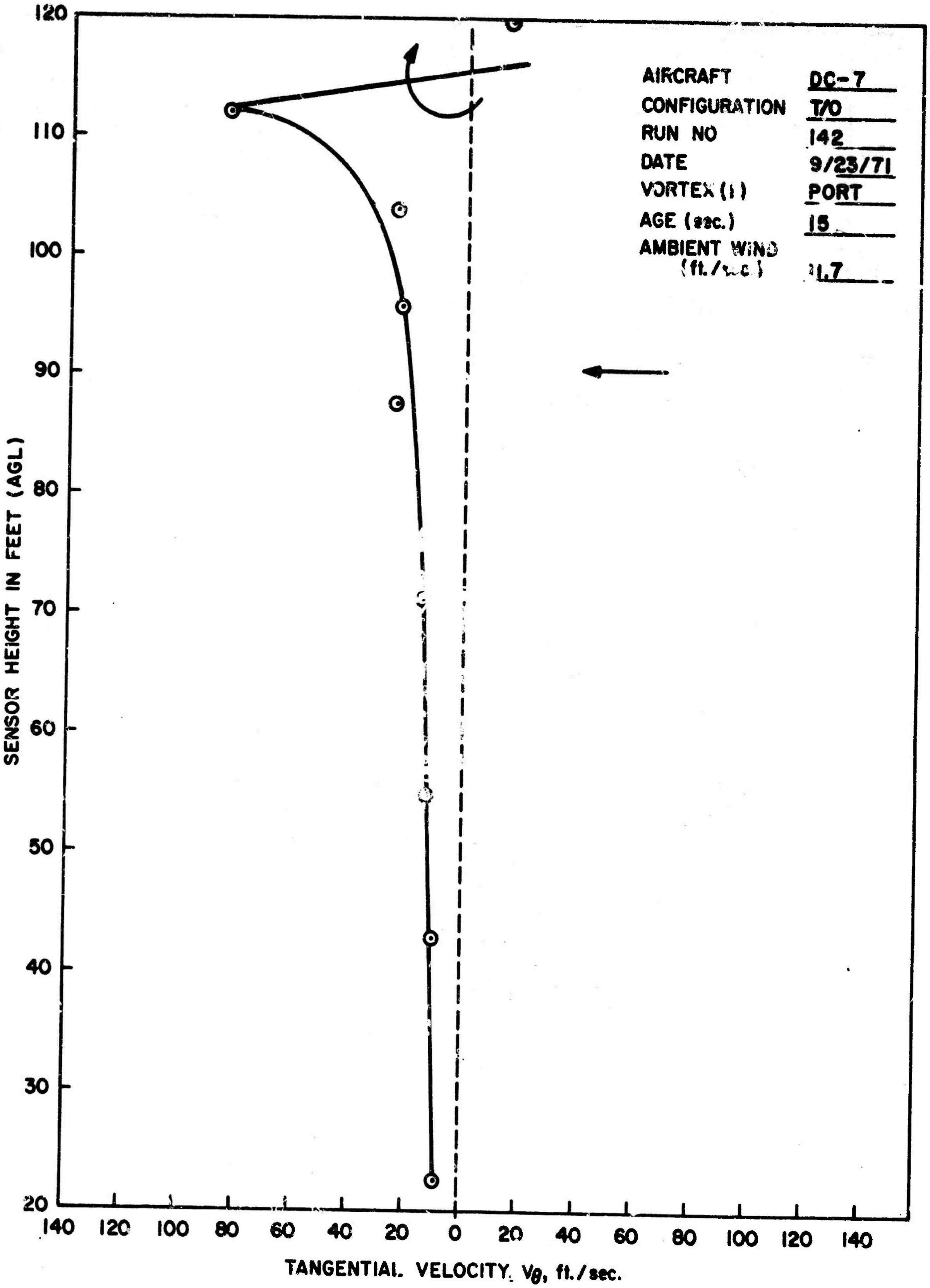

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 160
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 14
AMBIENT WIND (ft./sec.) 8
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 174
DATE 9/24/71
VORTEX (1) STBD.
AGE (sec.) 14
AMBIENT WIND (ft./sec.) 15
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

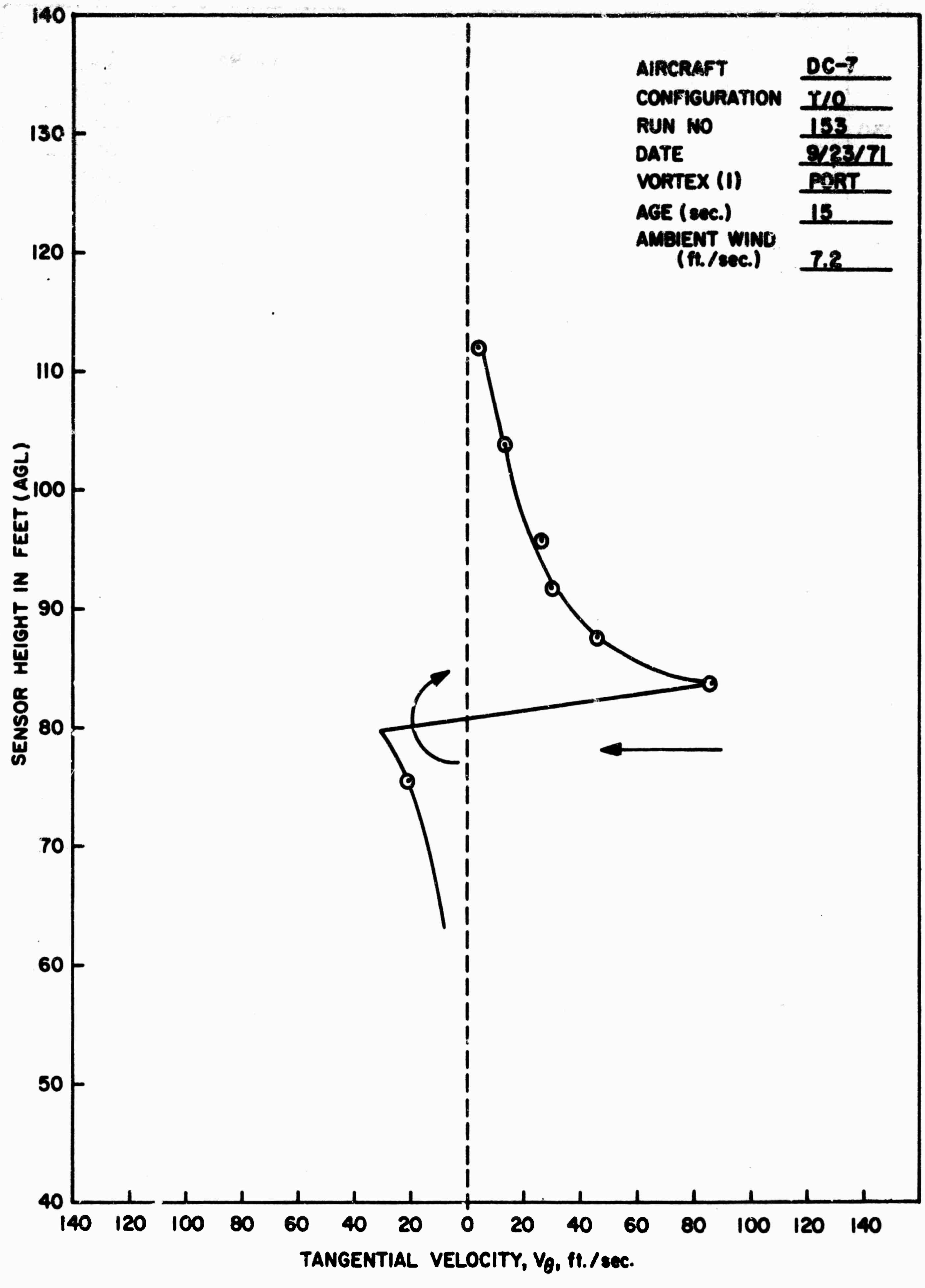

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 175
DATE 9/24/71
VORTEX (1) STBD
AGE (sec.) 14
AMBIENT WIND (ft./sec.) 17
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

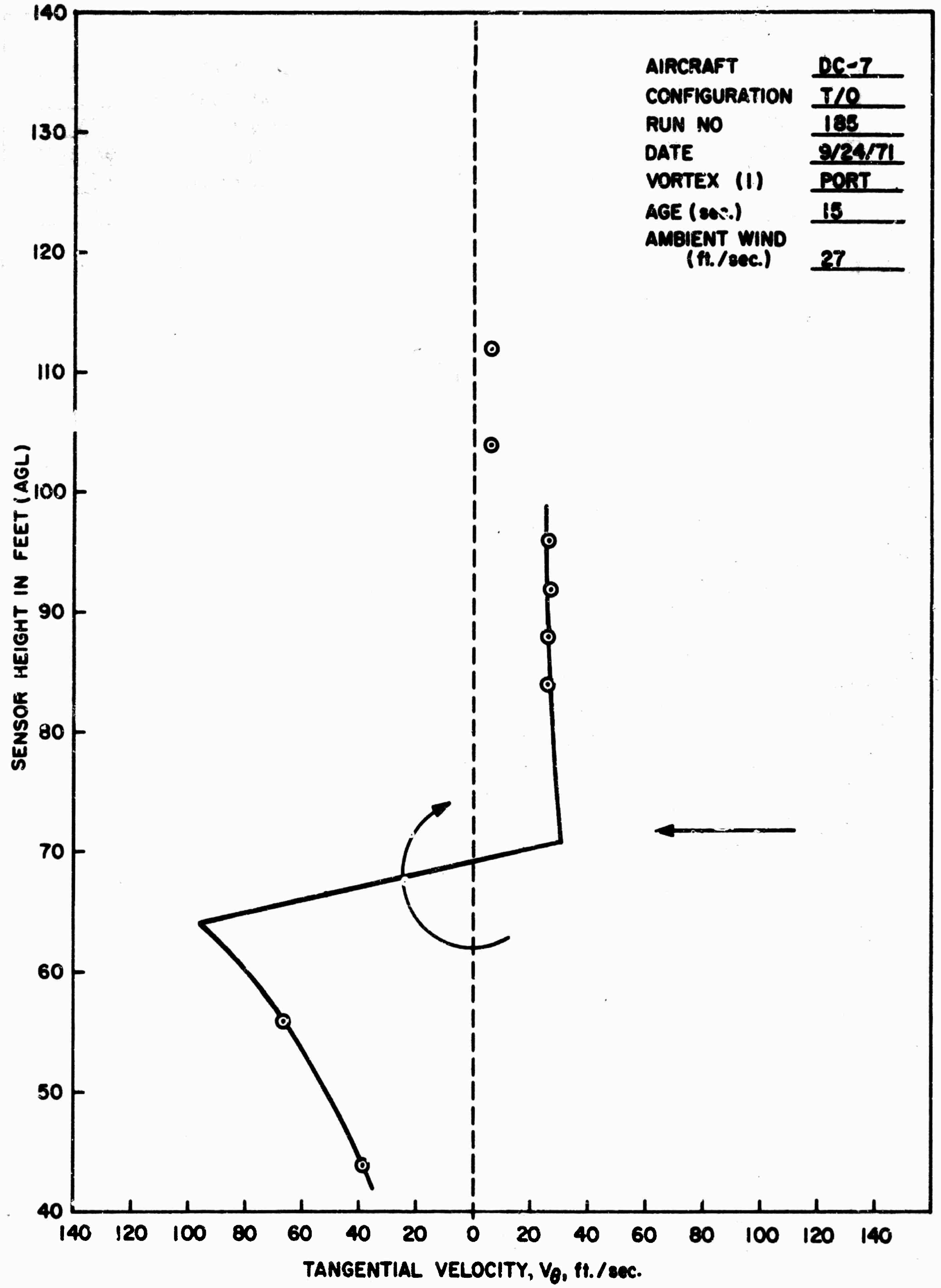


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 109
DATE 9/17/71
VORTEX (2) STBD
AGE (sec.) 15
AMBIENT WIND (ft./sec.) 14.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

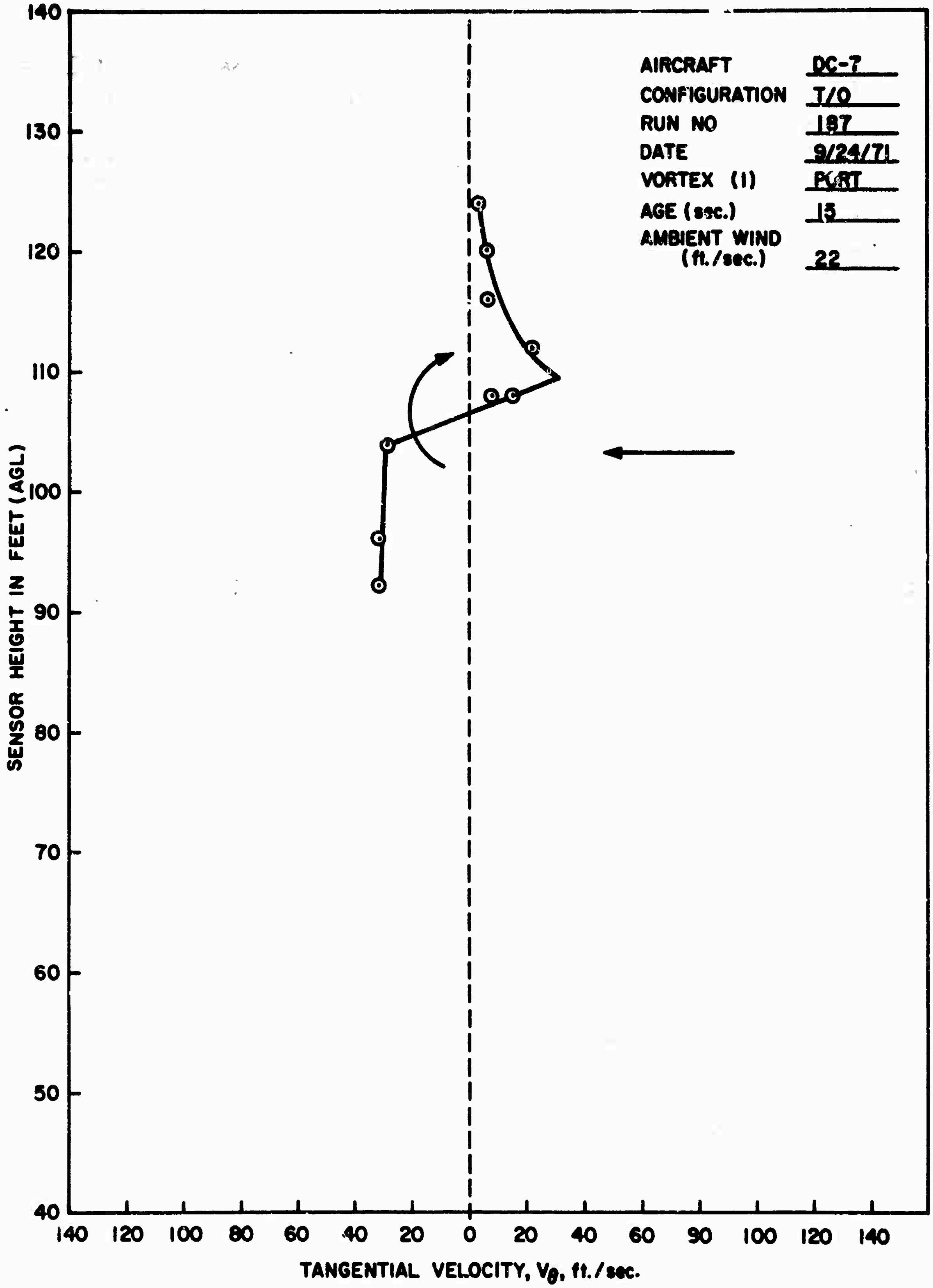


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 142
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 15
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
120
110
100
90
80
70
60
50
40
30
20
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

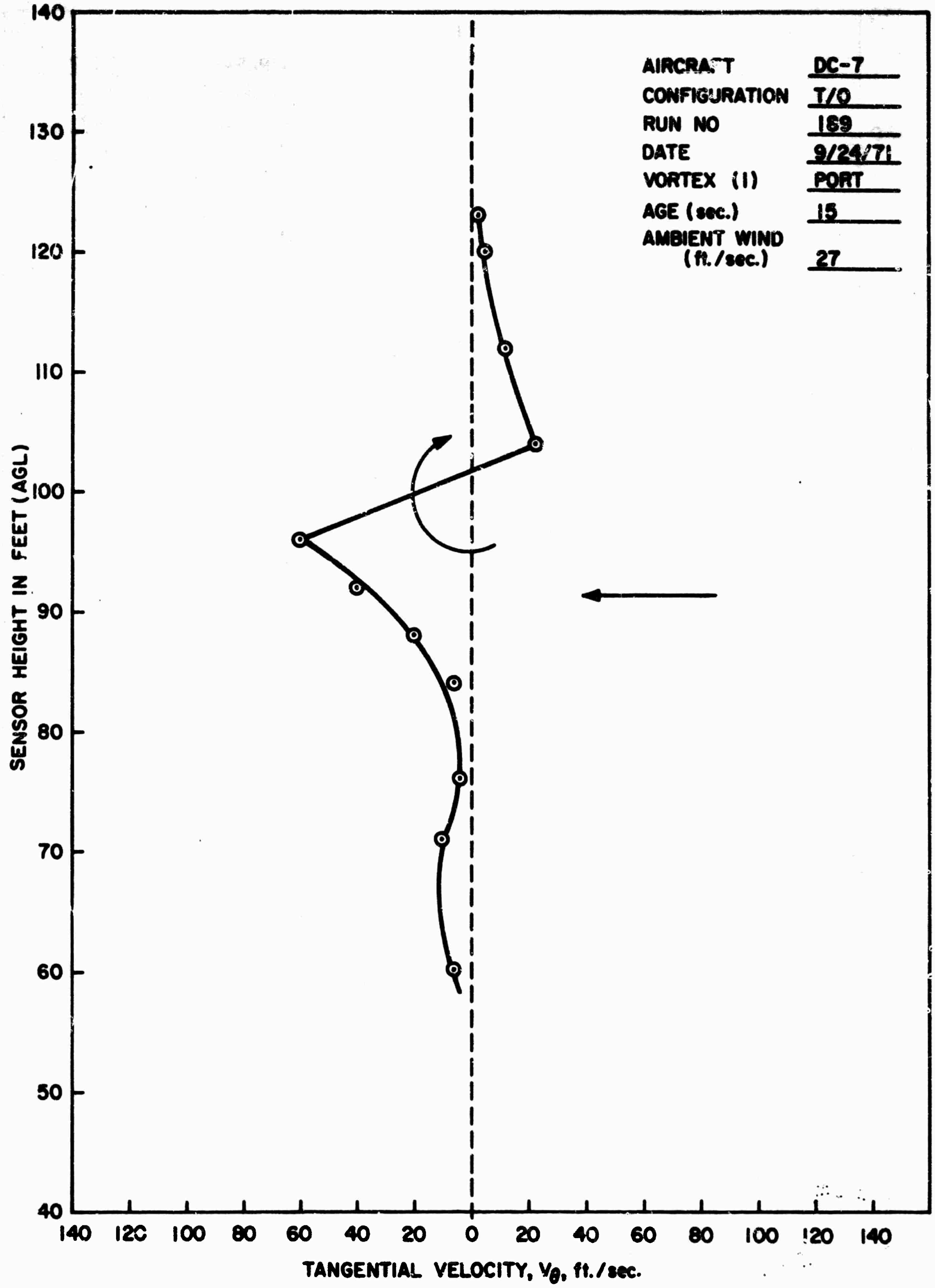

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 153
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 15
AMBIENT WIND (ft./sec.) 7.2
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

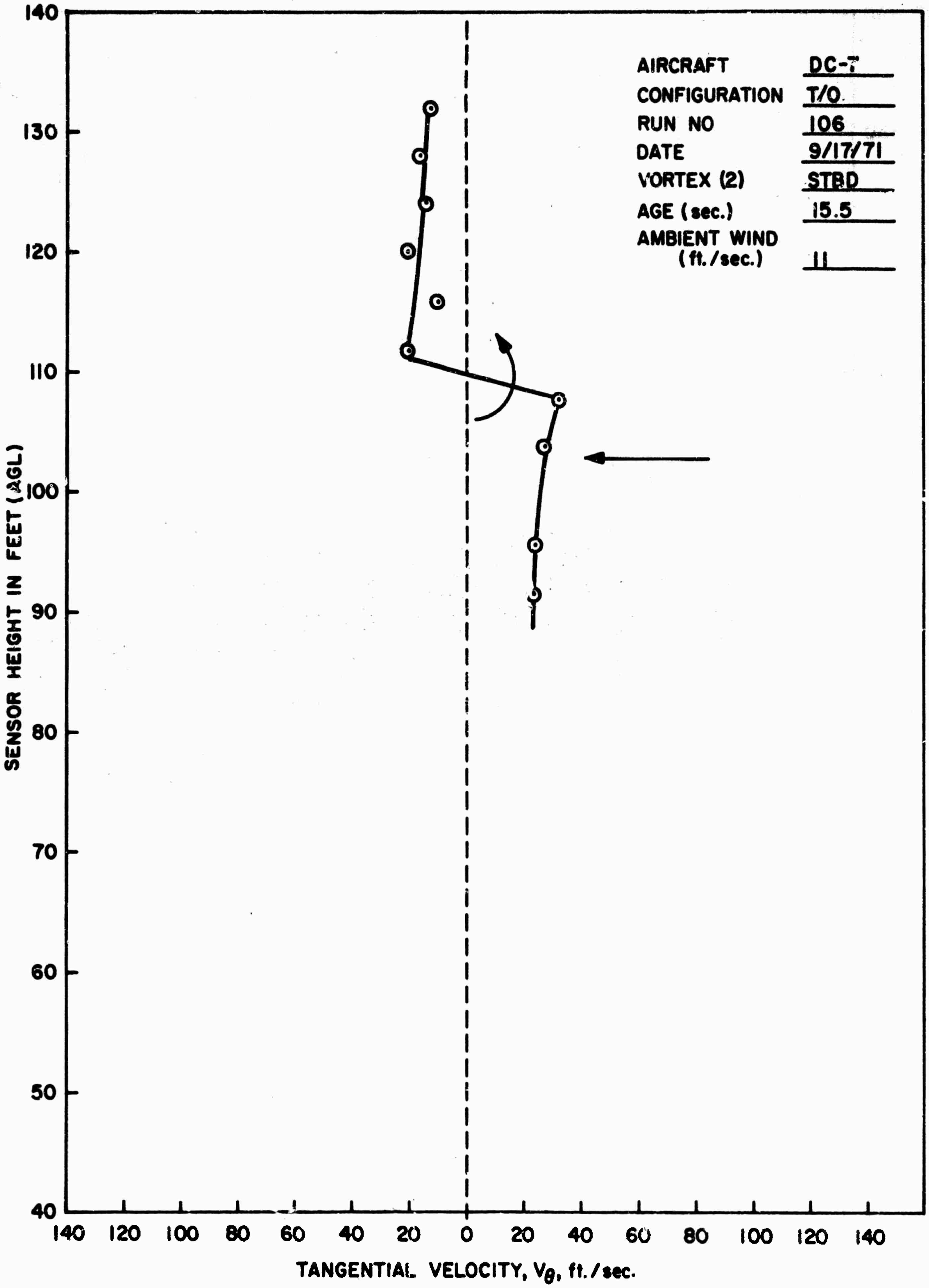


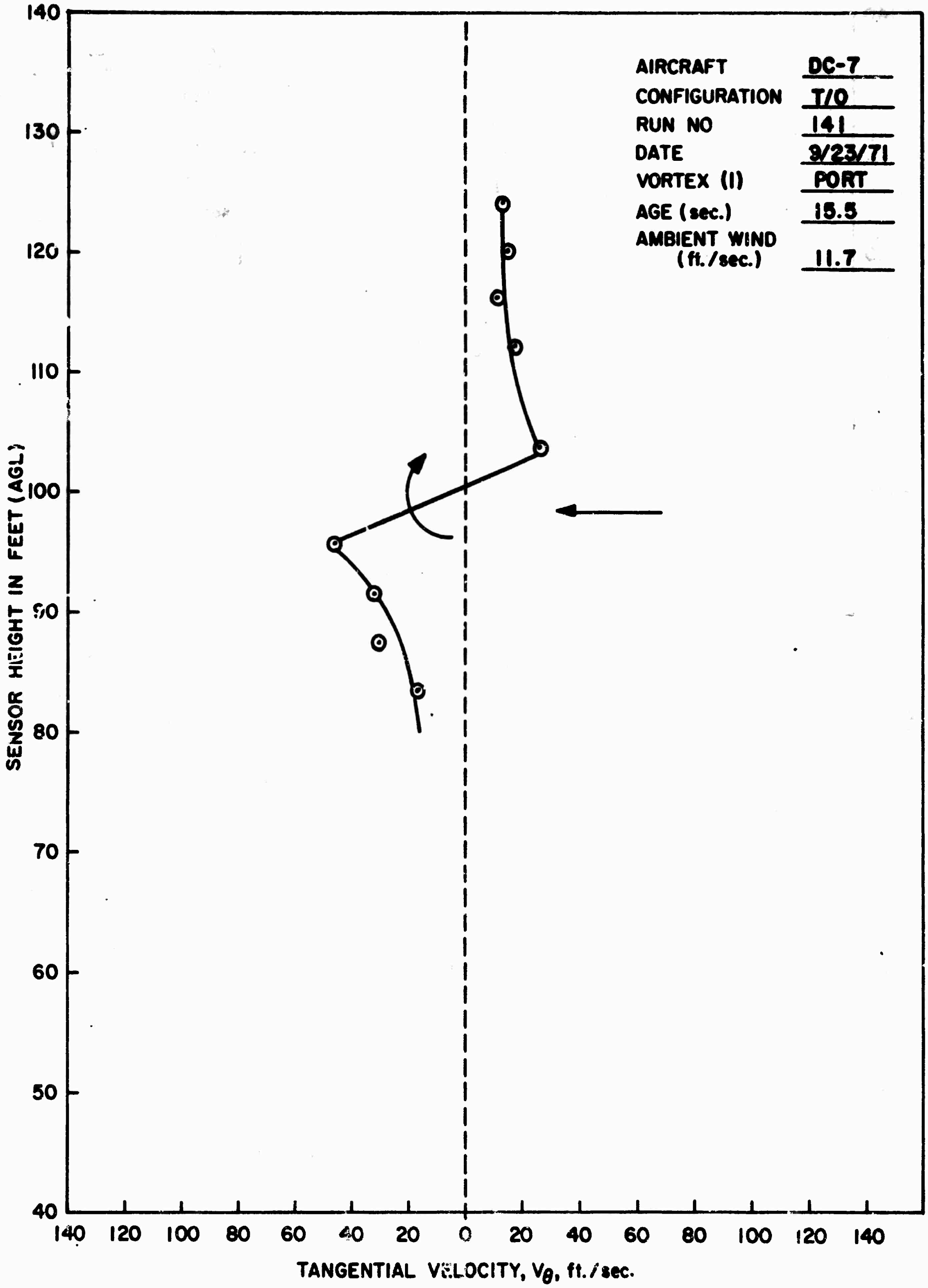
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 185
DATE 9/24/71
VORTEX (1) PORT
AGE (sec.) 15
AMBIENT WIND (ft./sec.) 27
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



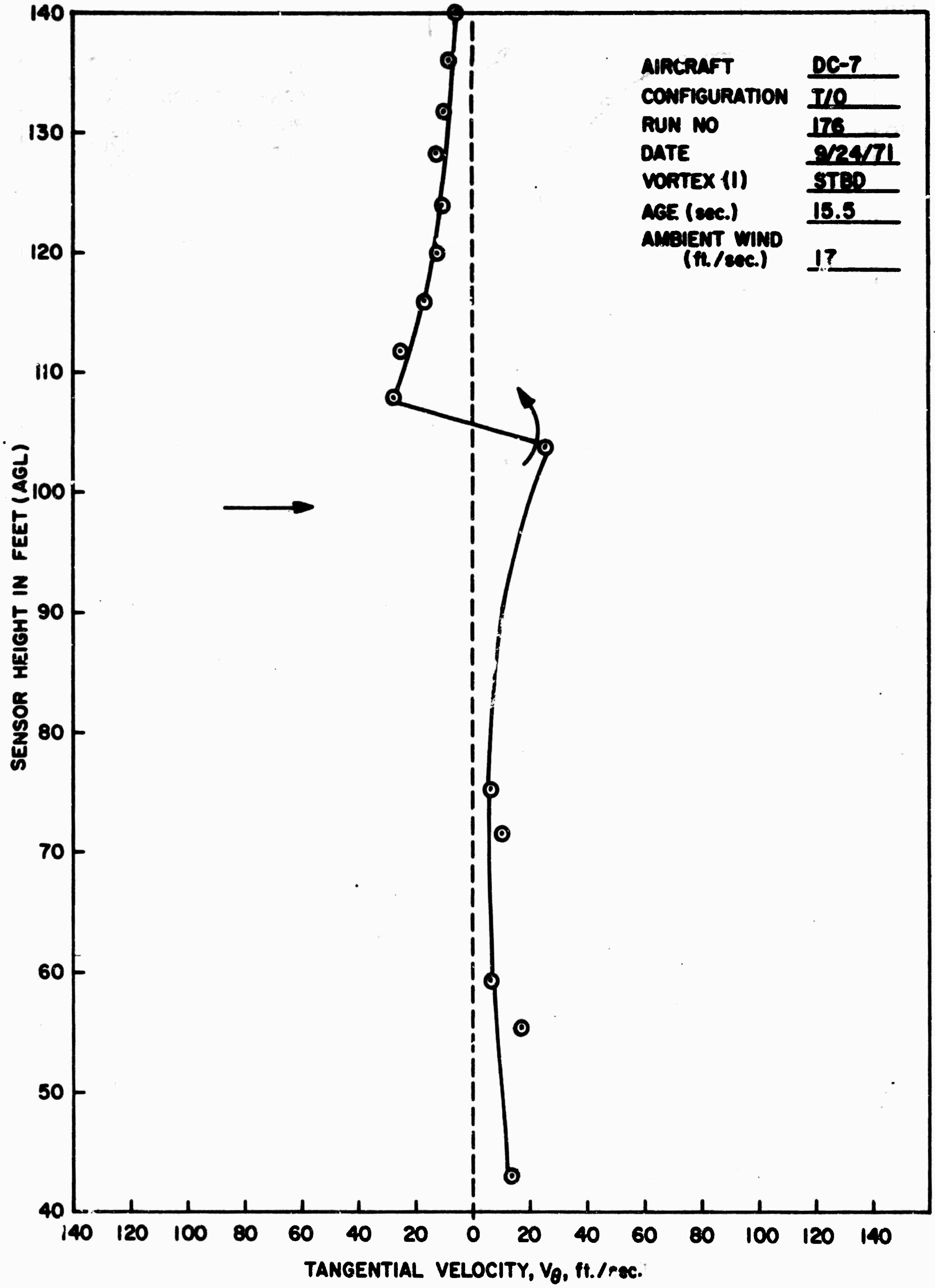
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 187
DATE 9/24/71
VORTEX (1) PORT
AGE (sec.) 15
AMBIENT WIND (ft./sec.) 22
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 90 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

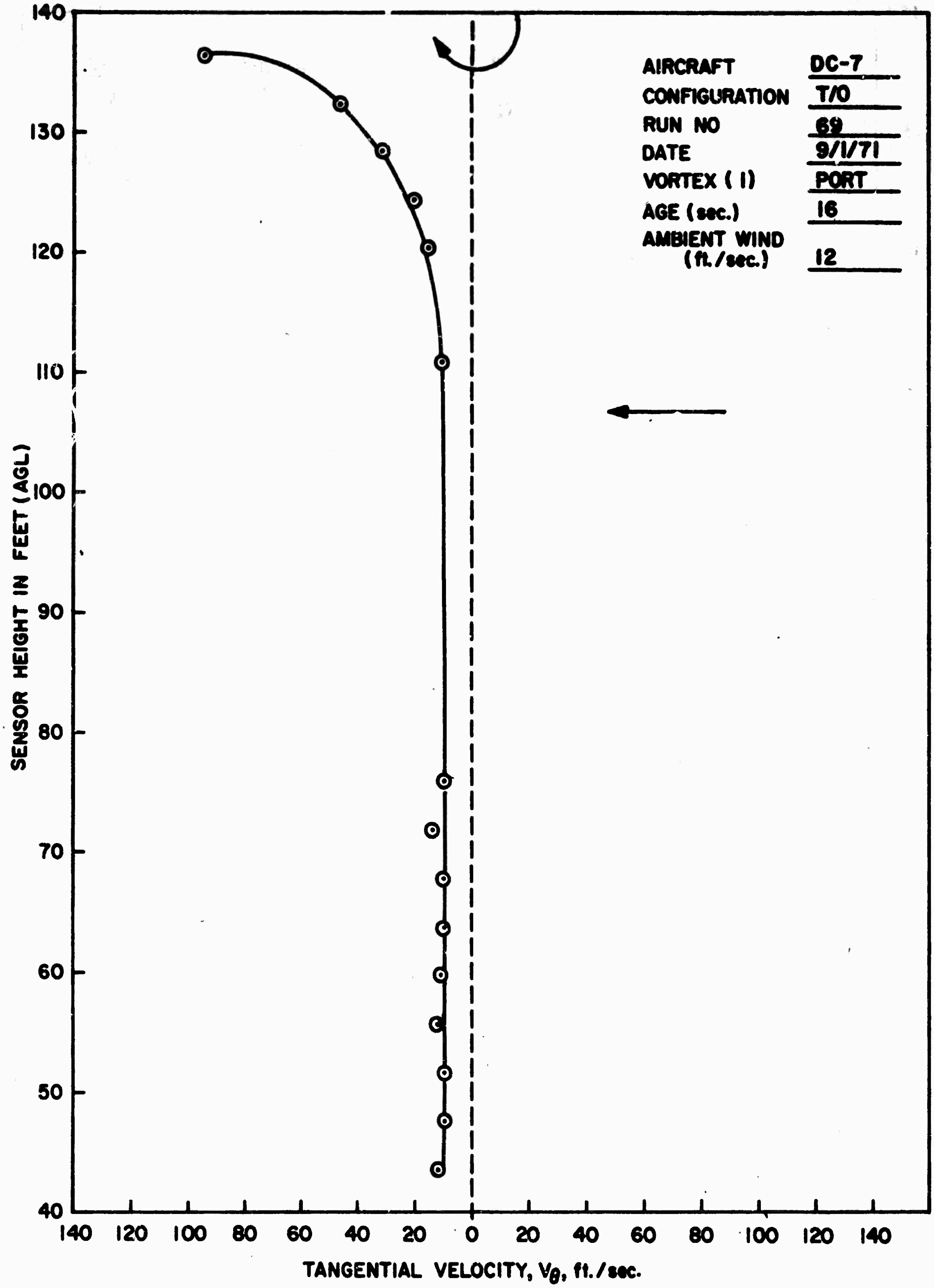

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 189
DATE 9/24/71
VORTEX (1) PORT
AGE (sec.) 15
AMBIENT WIND (ft./sec.) 27
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

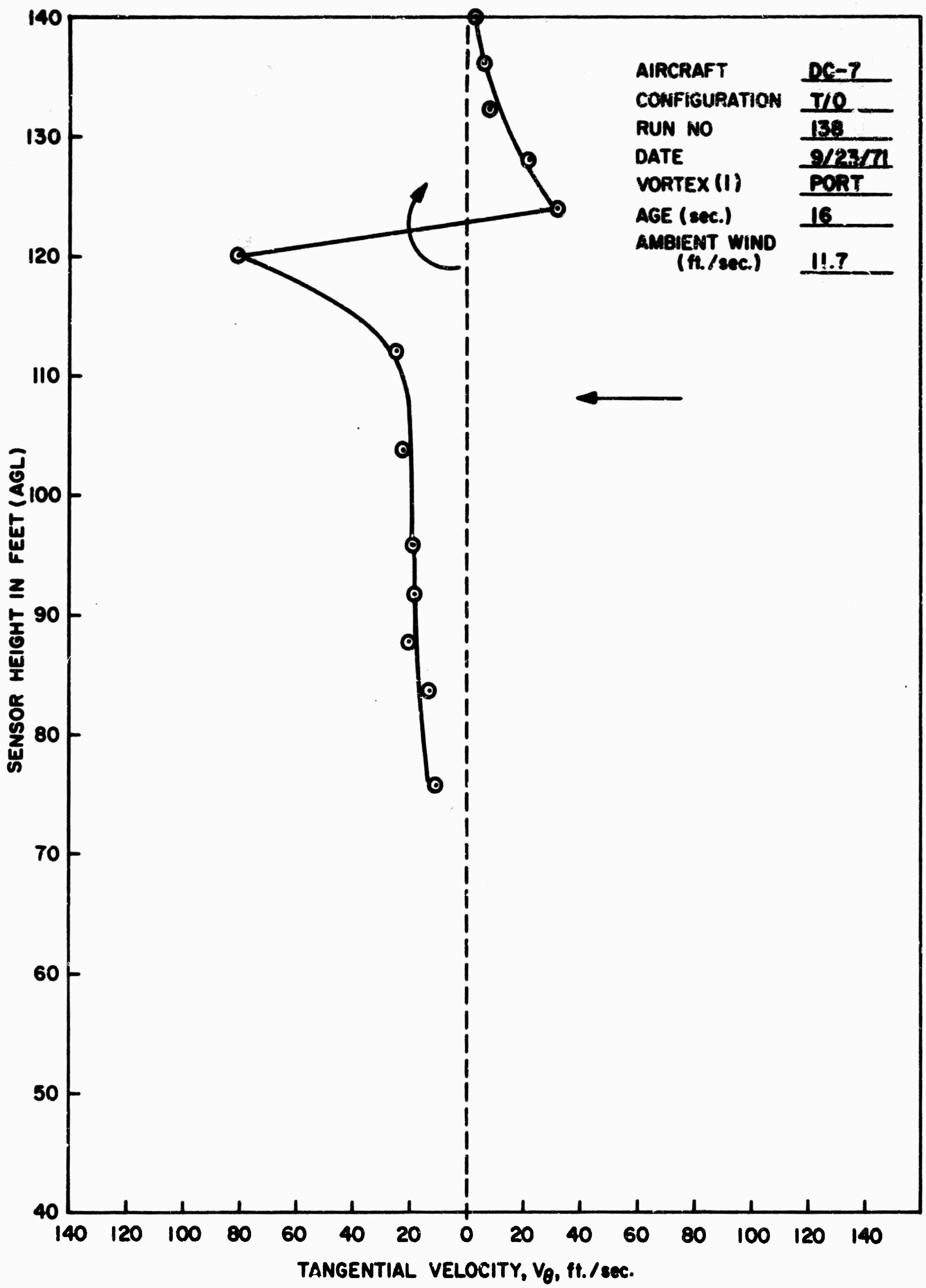

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 106
DATE 9/17/71
VORTEX (2) STBD
AGE (sec.) 15.5
AMBIENT WIND (ft./sec.) 11
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

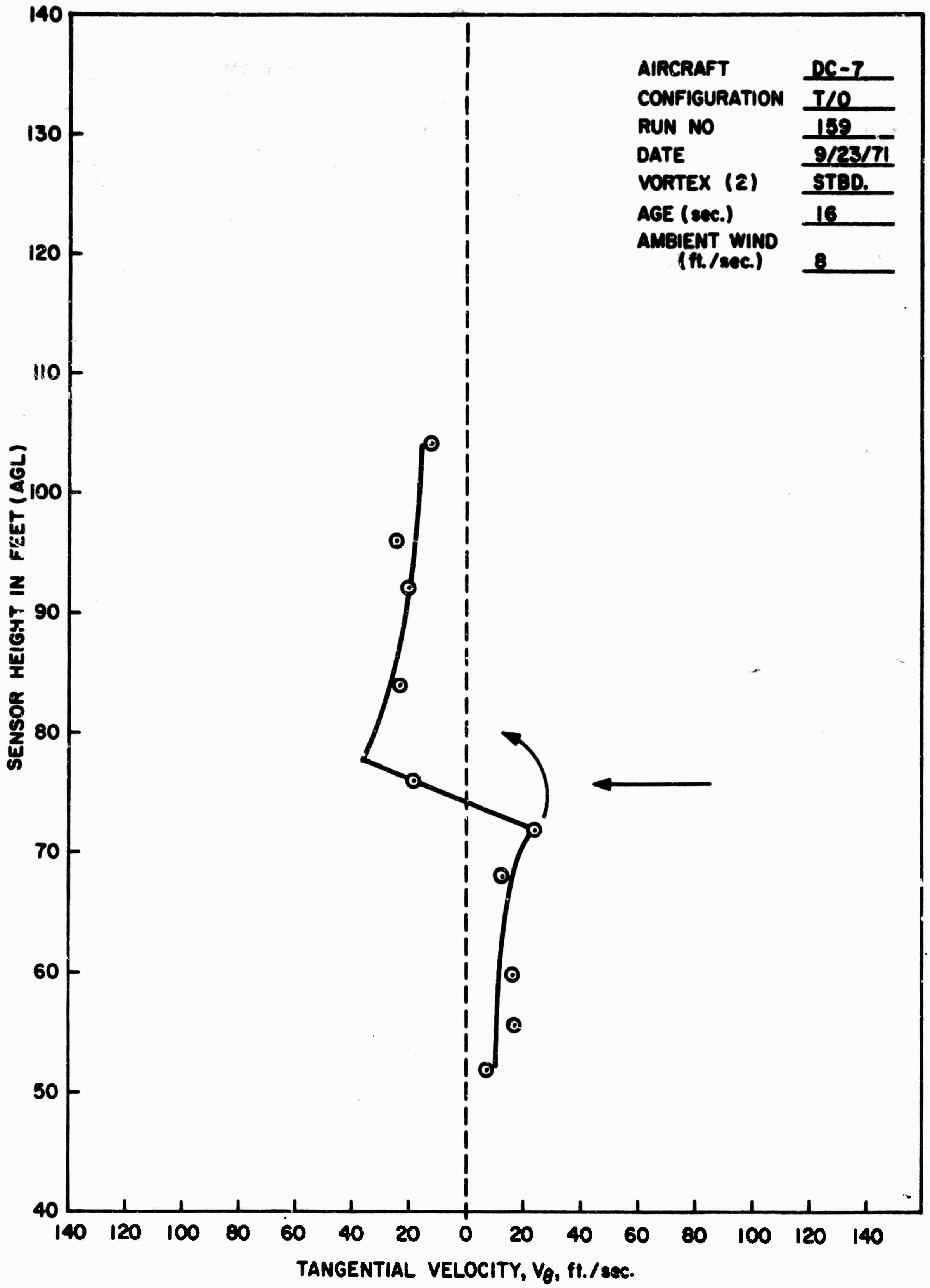


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 141
DATE 9/23/71
VORTEX (I) PORT
AGE (sec.) 15.5
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.

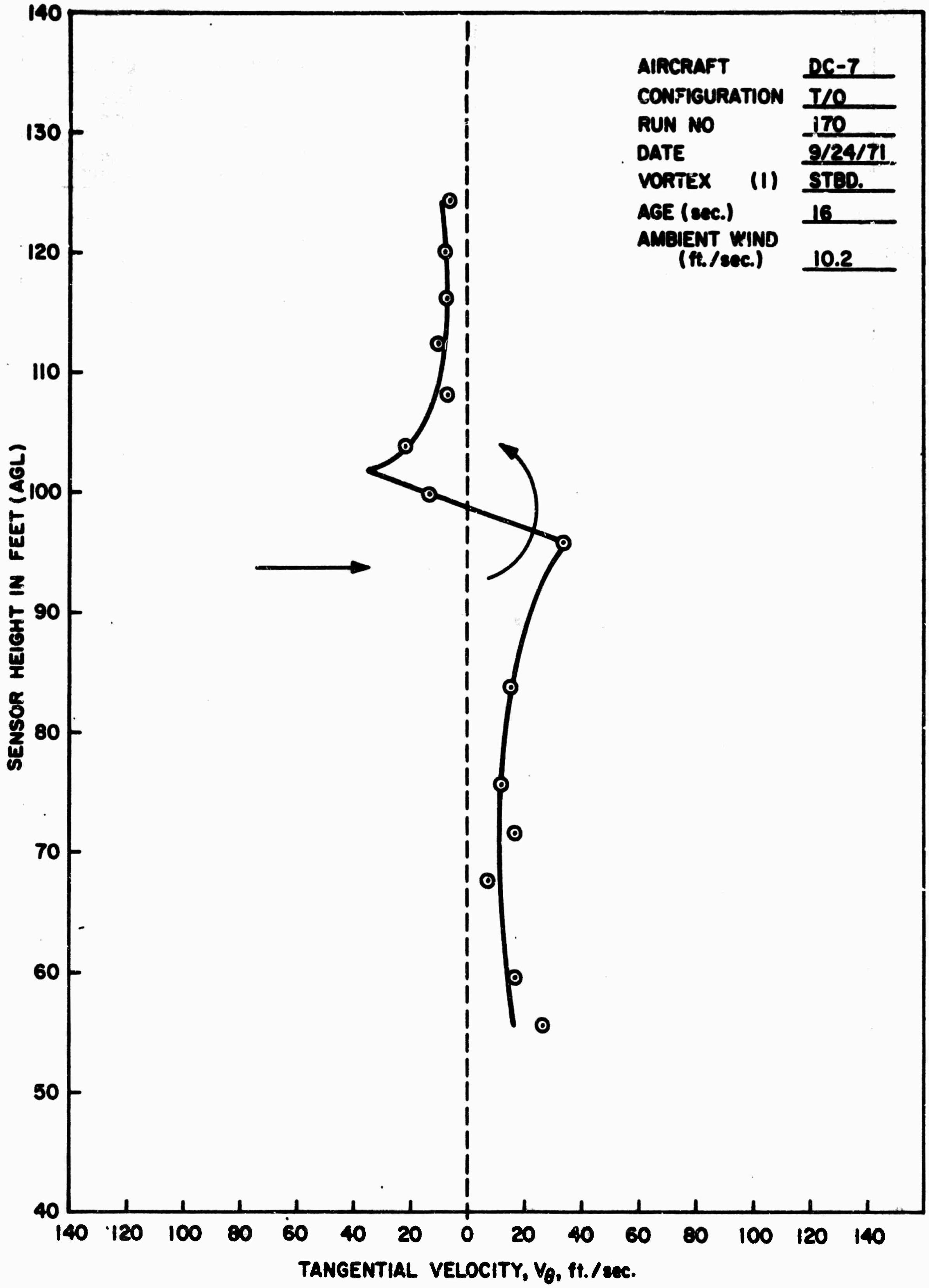

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 176
DATE 9/24/71
VORTEX (1) STBD
AGE (sec.) 15.5
AMBIENT WIND (ft./sec.) 17
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 69
DATE 9/1/71
VORTEX (1) PORT
AGE (sec.) 16
AMBIENT WIND (ft./sec.) 12
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

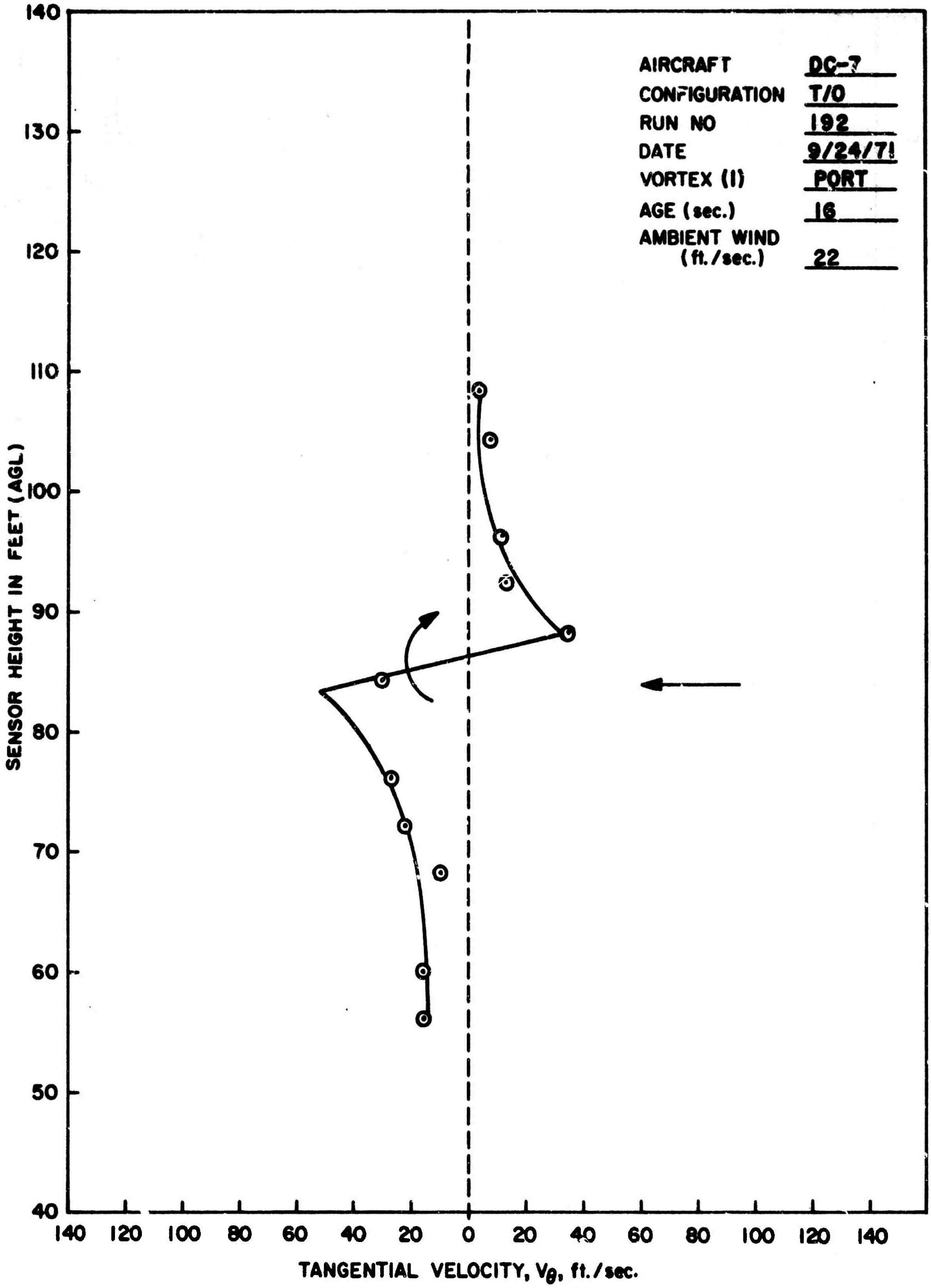

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 138
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 16
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

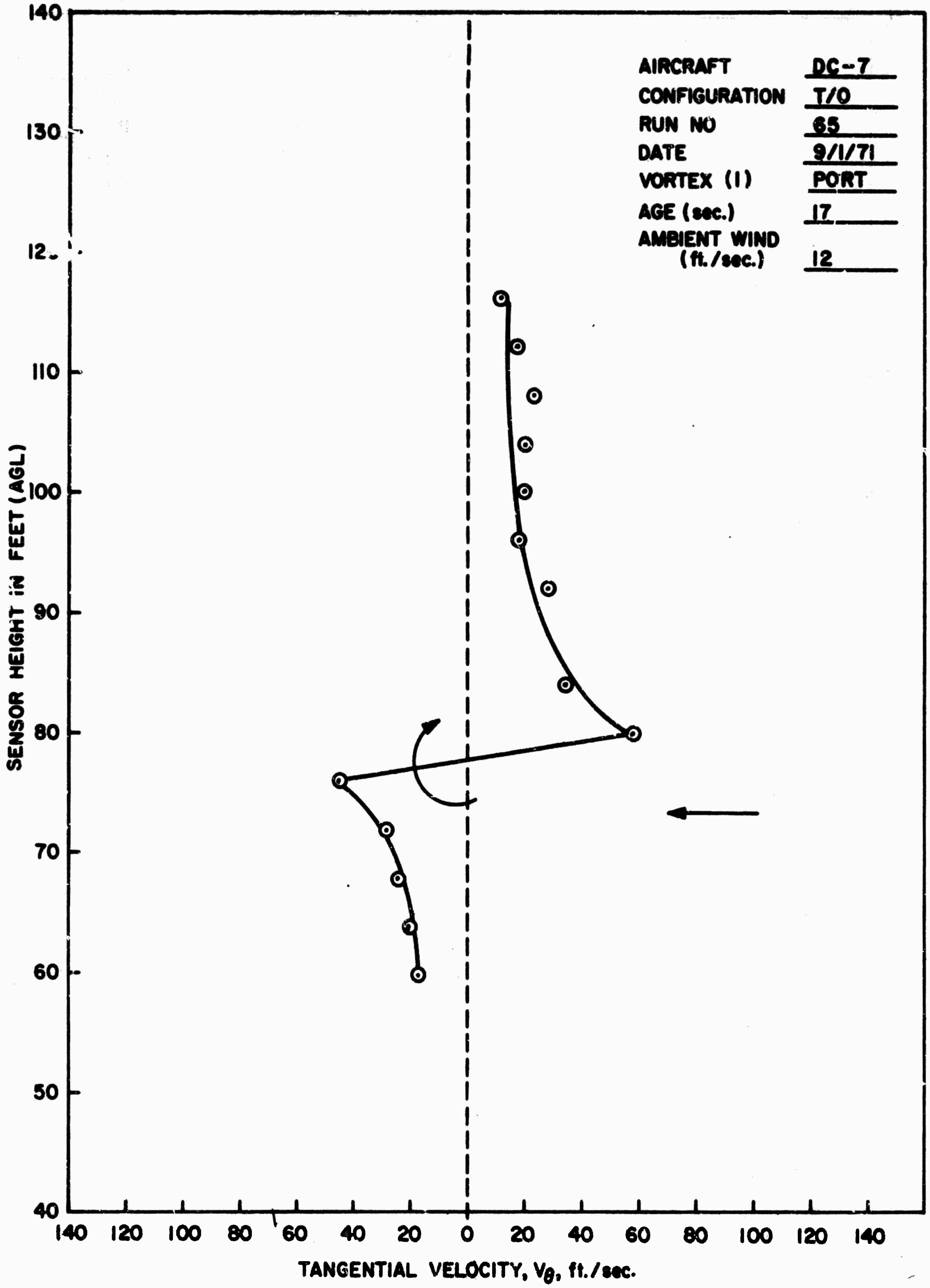


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 159
DATE 9/23/71
VORTEX (2) STBD.
AGE (sec.) 16
AMBIENT WIND (ft./sec.) 8
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

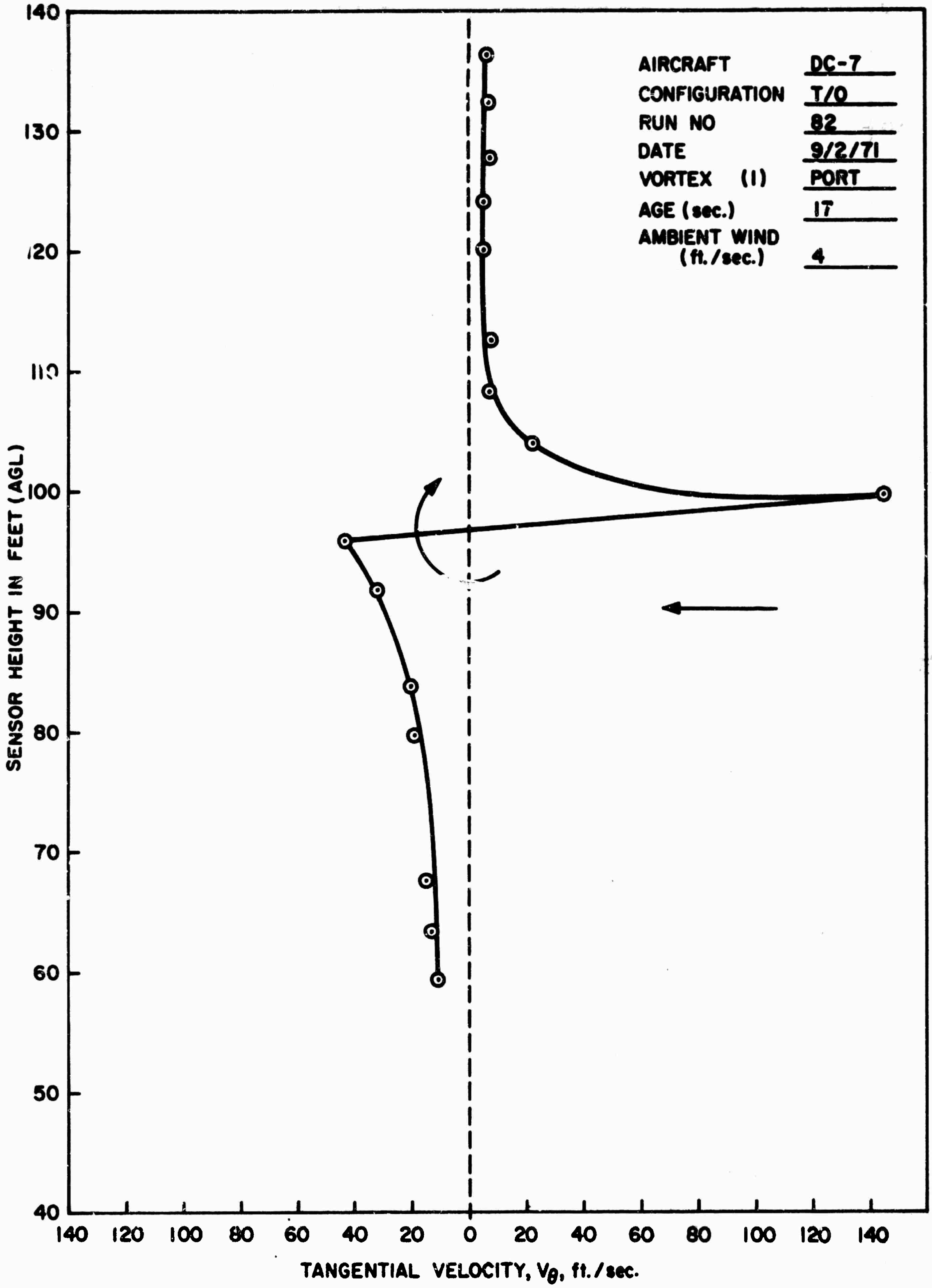


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 170
DATE 9/24/71
VORTEX (1) STBD.
AGE (sec.) 16
AMBIENT WIND (ft./sec.) 10.2
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

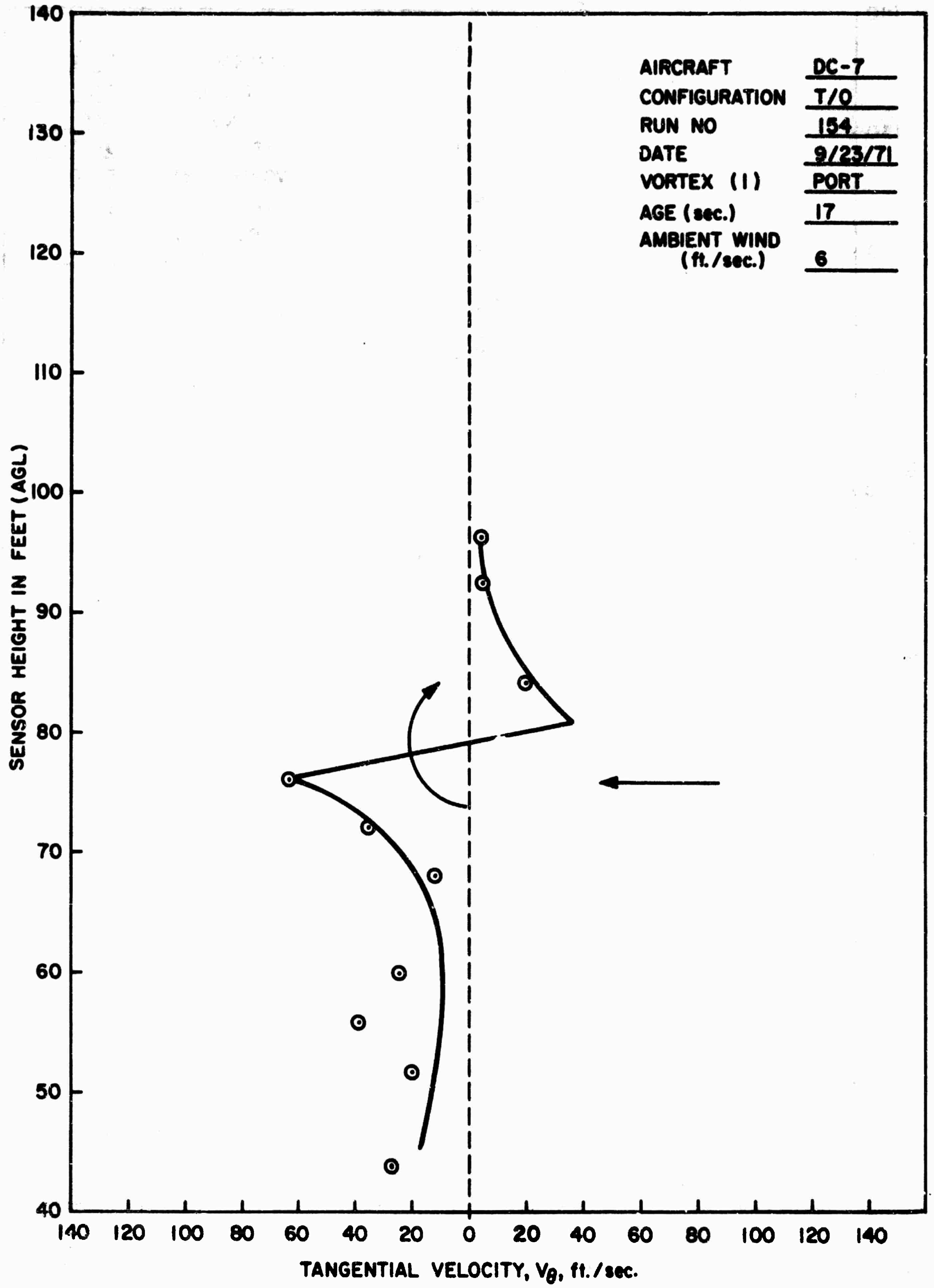

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 192
DATE 9/24/71
VORTEX (1) PORT
AGE (sec.) 16
AMBIENT WIND (ft./sec.) 22
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140



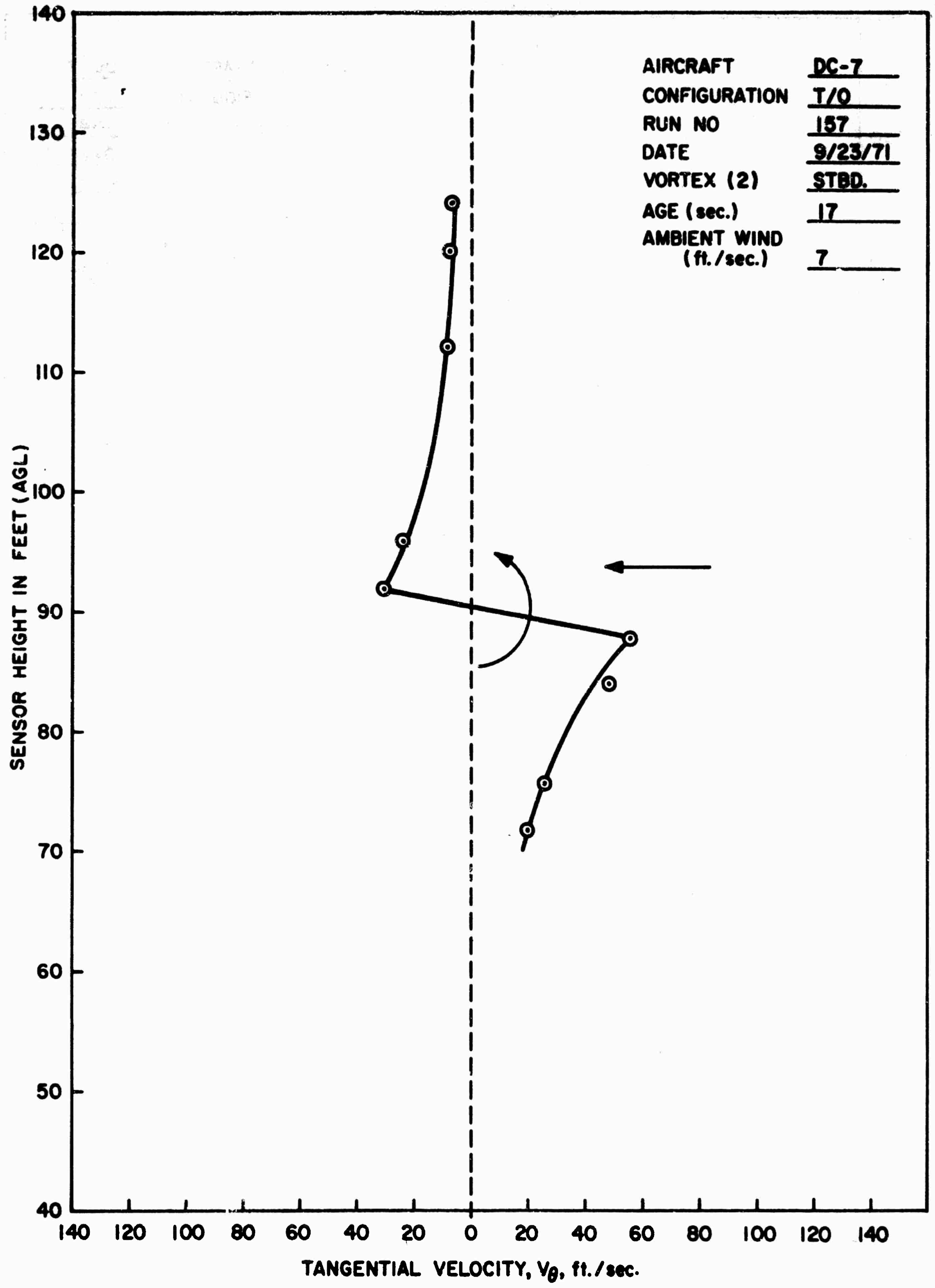
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 65
DATE 9/1/71
VORTEX (1) PORT
AGE (sec.) 17
AMBIENT WIND (ft./sec.) 12
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, Vθ, ft./sec.
140
130
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140



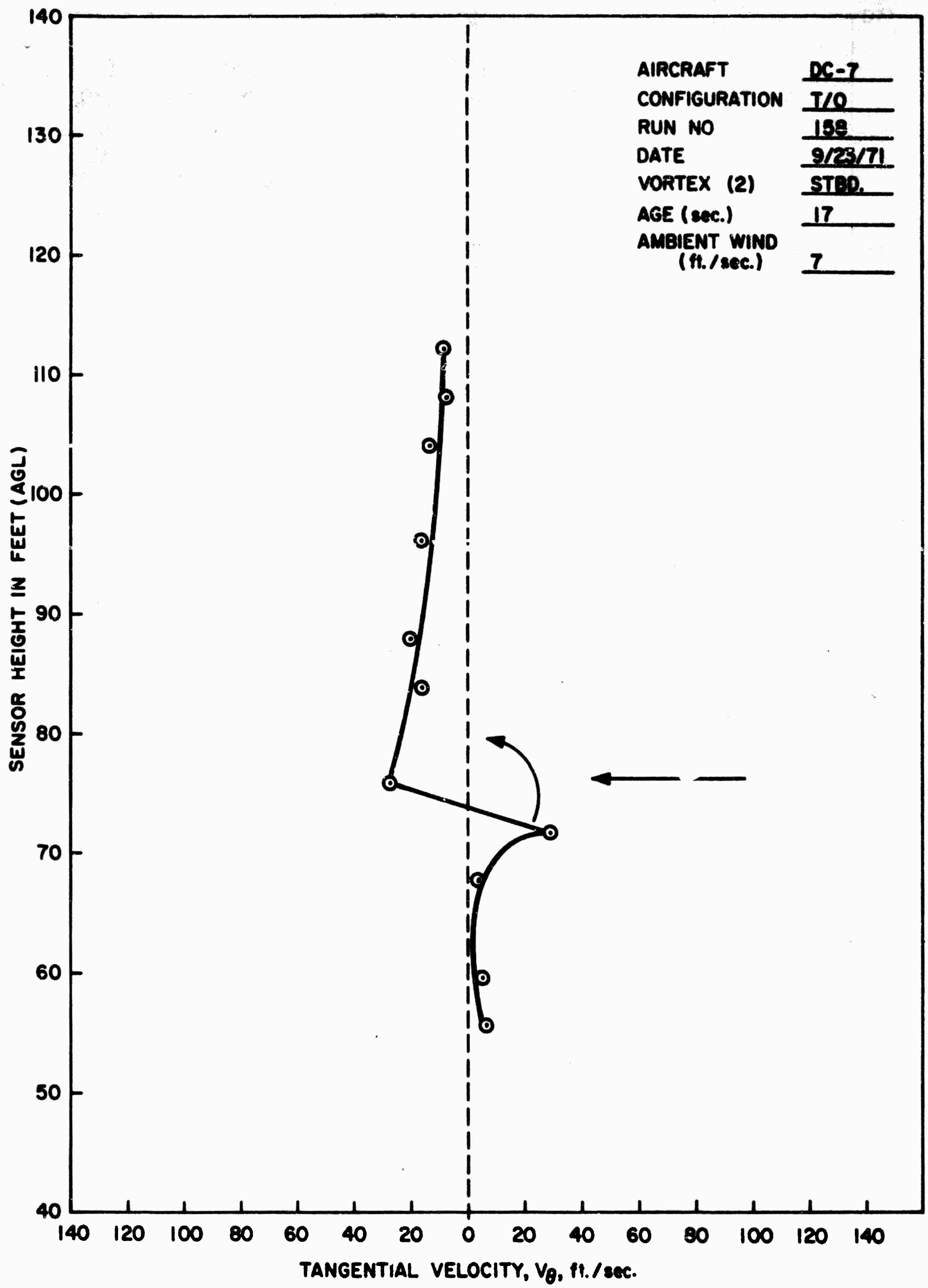
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 82
DATE 9/2/71
VORTEX (1) PORT
AGE (sec.) 17
AMBIENT WIND (ft./sec.) 4
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



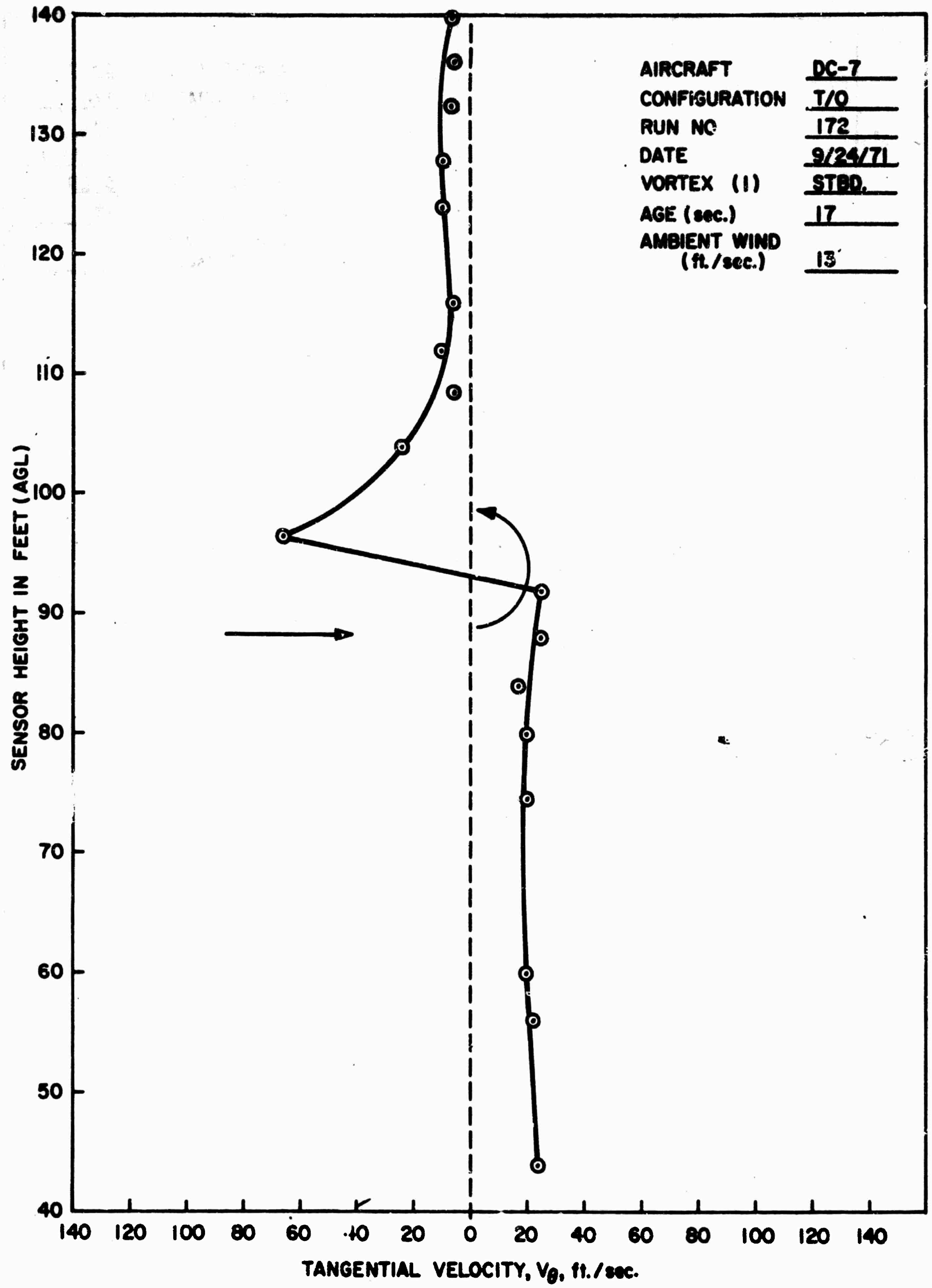
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 154
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 17
AMBIENT WIND (ft./sec.) 6
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

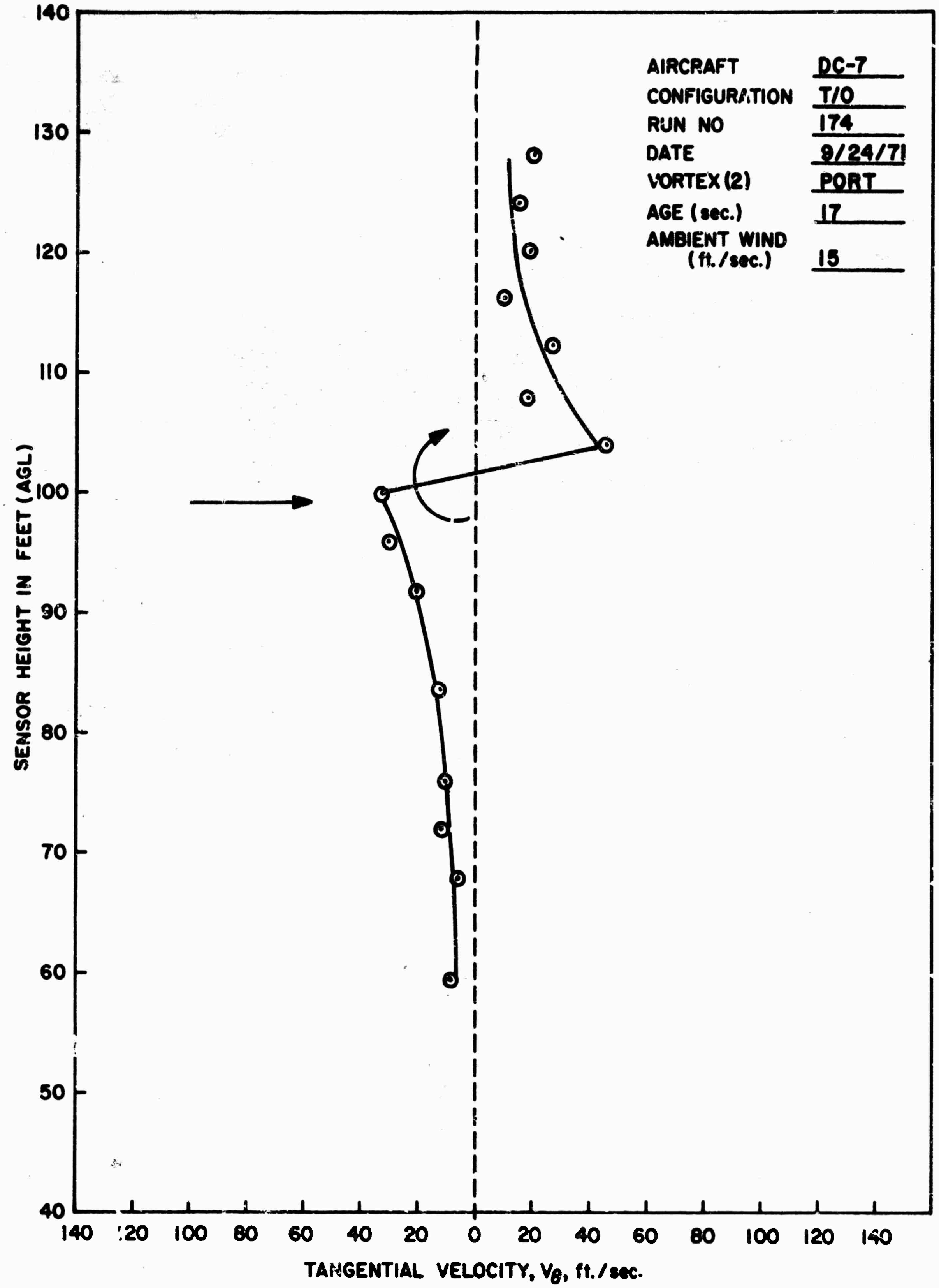


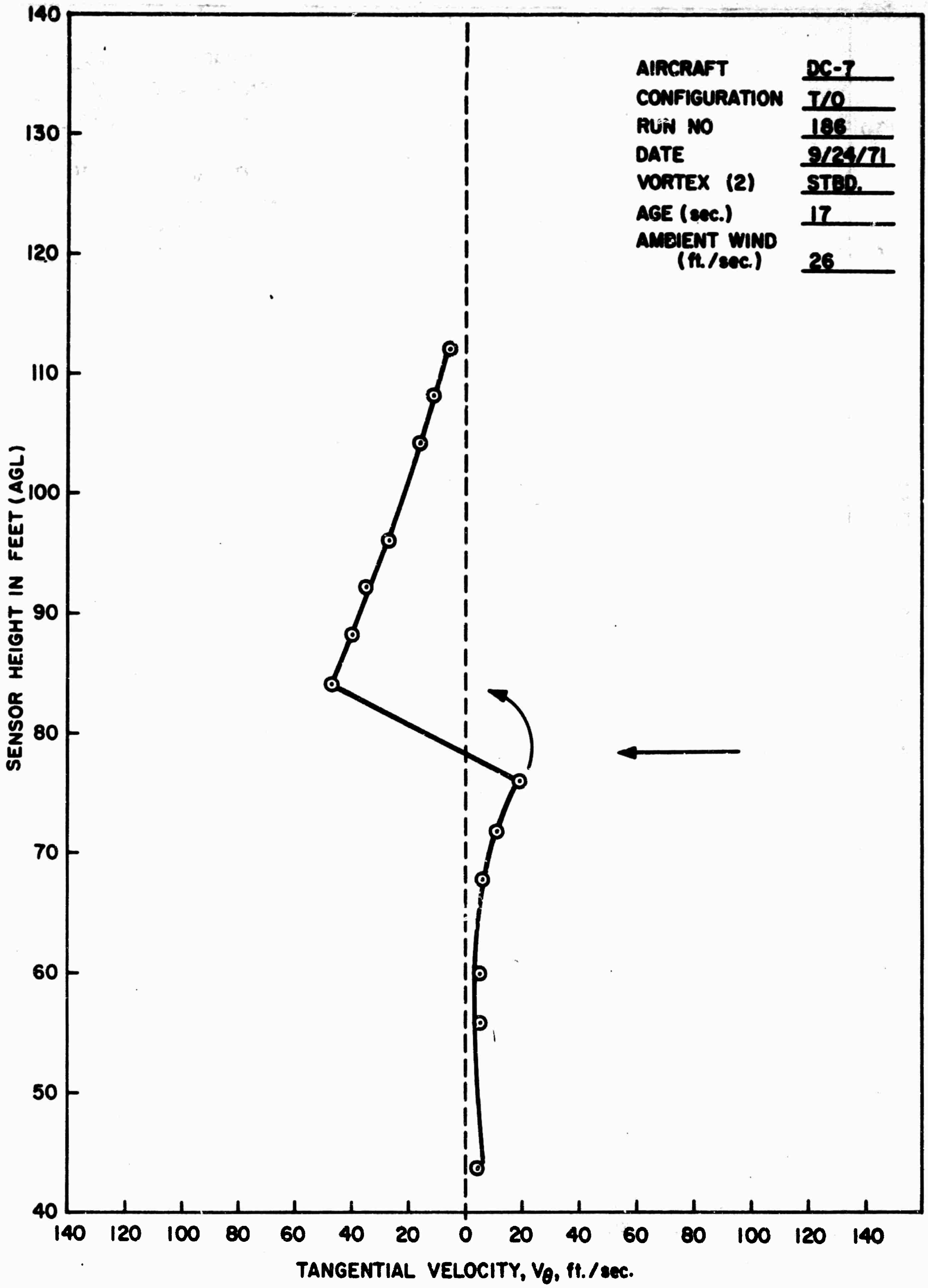
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 157
DATE 9/23/71
VORTEX (2) STBD.
AGE (sec.) 17
AMBIENT WIND (ft./sec.) 7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

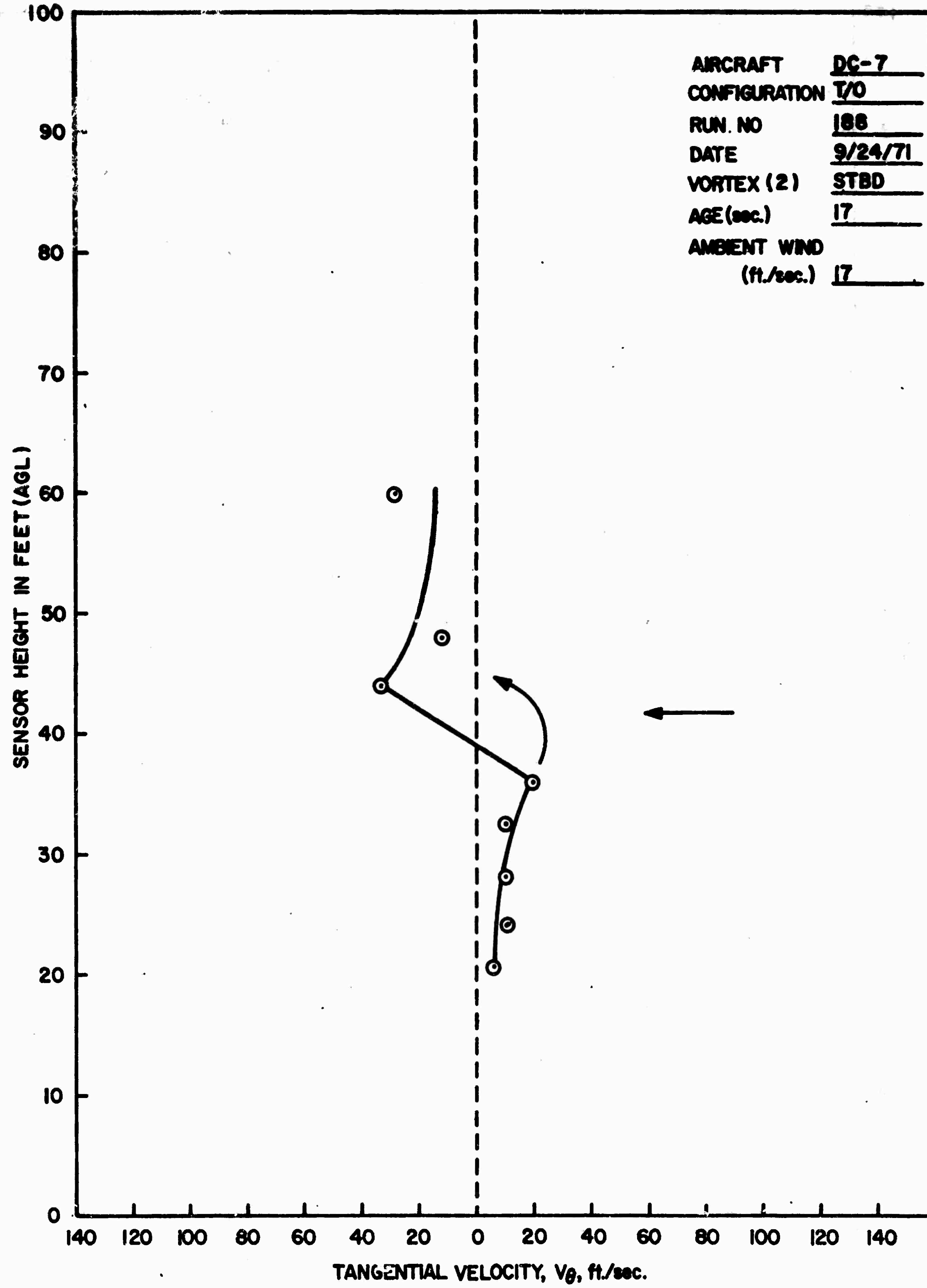


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 158
DATE 9/23/71
VORTEX (2) STBD.
AGE (sec.) 17
AMBIENT WIND (ft./sec.) 7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

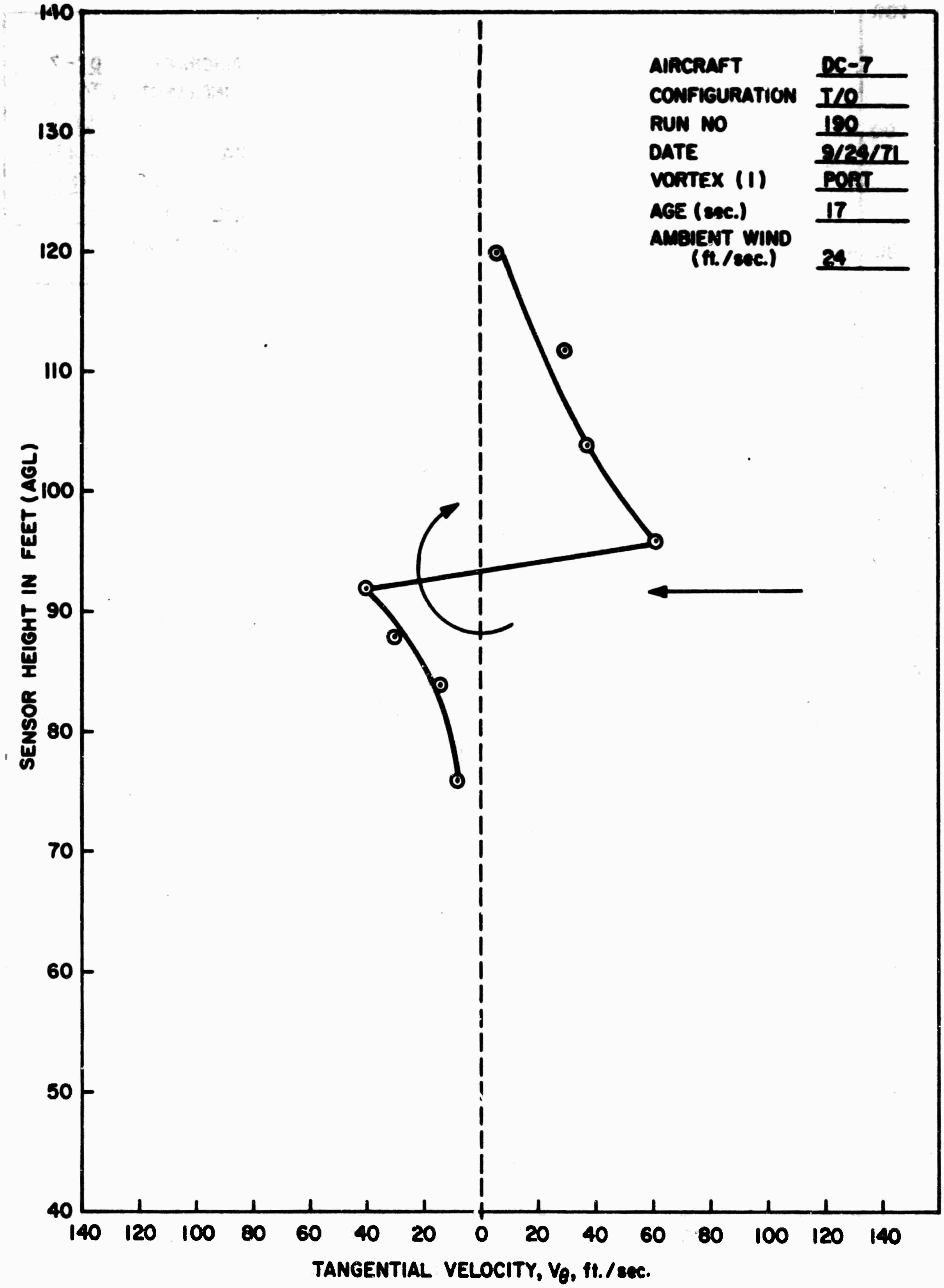

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 172
DATE 9/24/71
VORTEX (1) STBD.
AGE (sec.) 17
AMBIENT WIND (ft./sec.) 13
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 174
DATE 9/24/71
VORTEX (2) PORT
AGE (sec.) 17
AMBIENT WIND (ft./sec.) 15
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

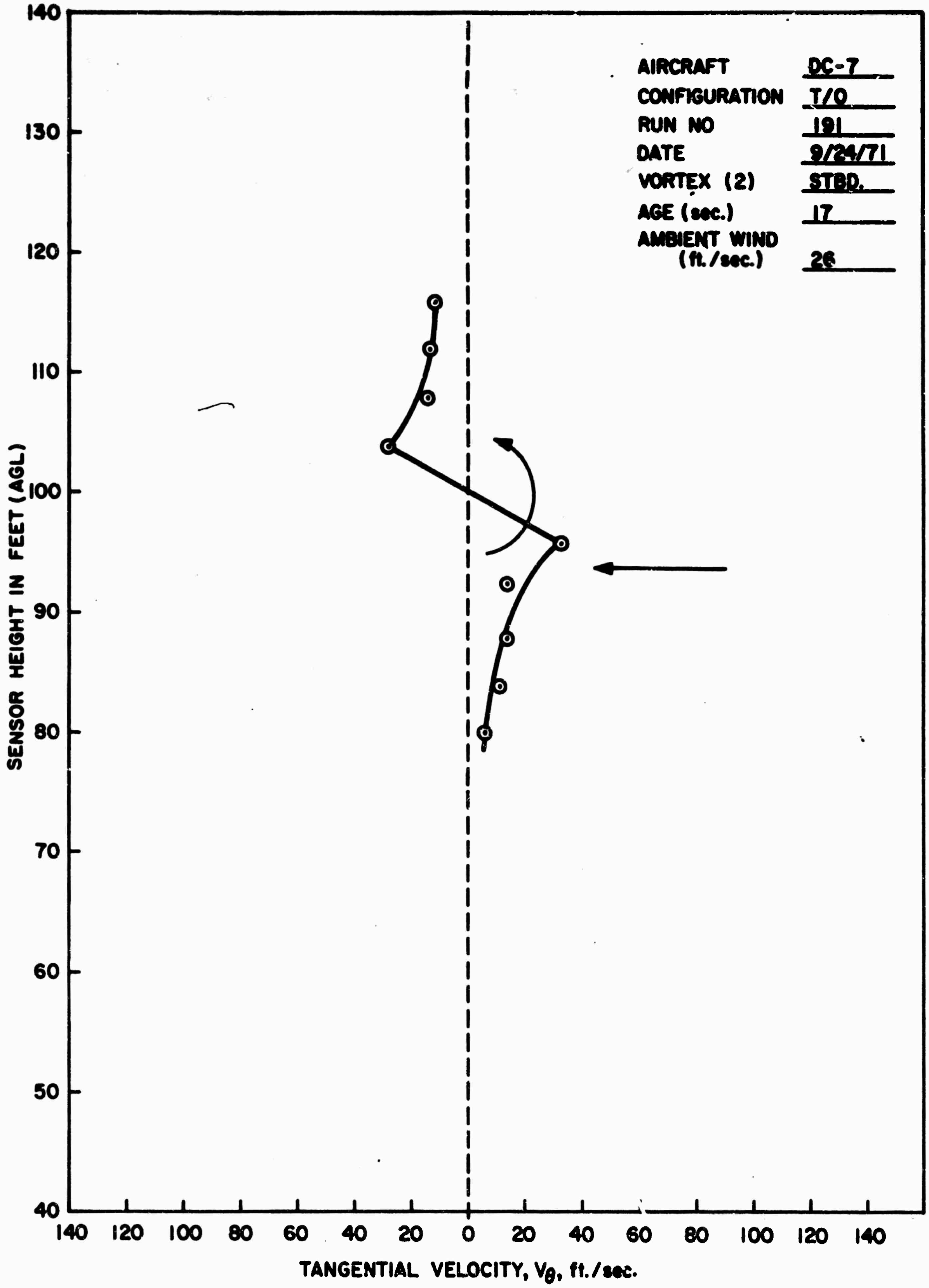

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 186
DATE 9/24/71
VORTEX (2) STBD.
AGE (sec.) 17
AMBIENT WIND (ft./sec.) 26
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

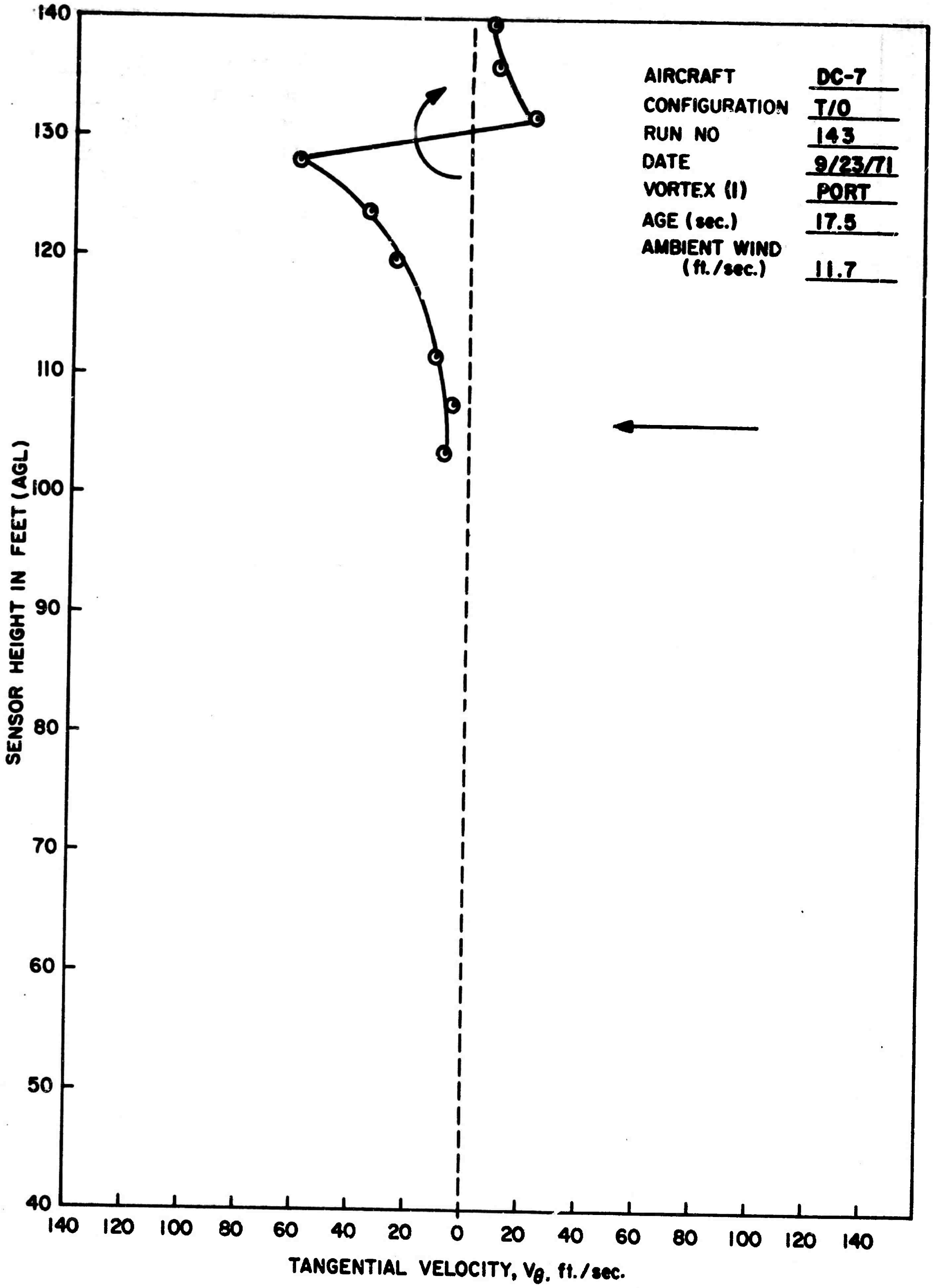


AIRCRAFT DC-7
CONFIGURATION T/O
RUN. NO 188
DATE 9/24/71
VORTEX (2) STBD
AGE (sec.) 17
AMBIENT WIND (ft./sec.) 17
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.

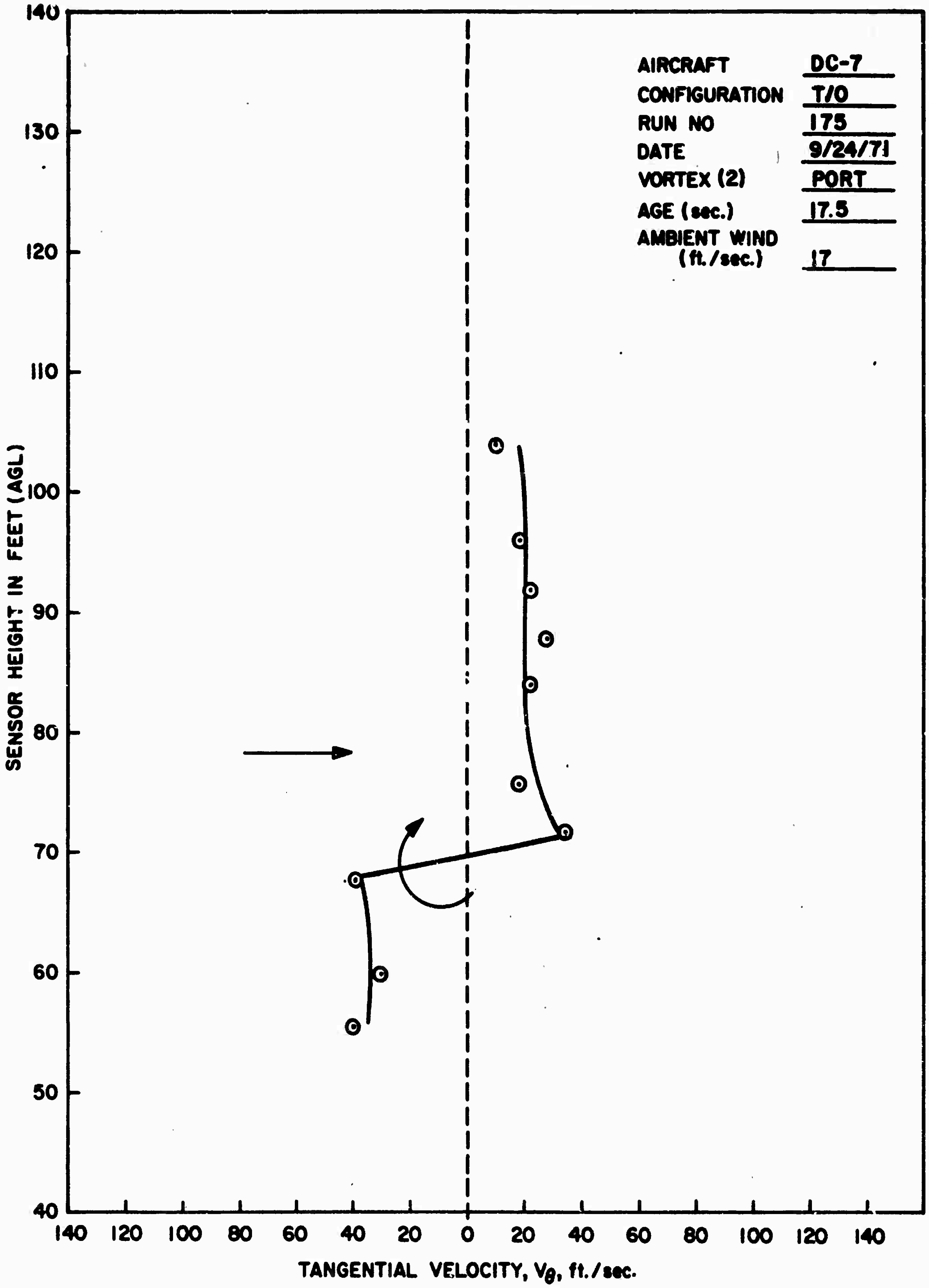


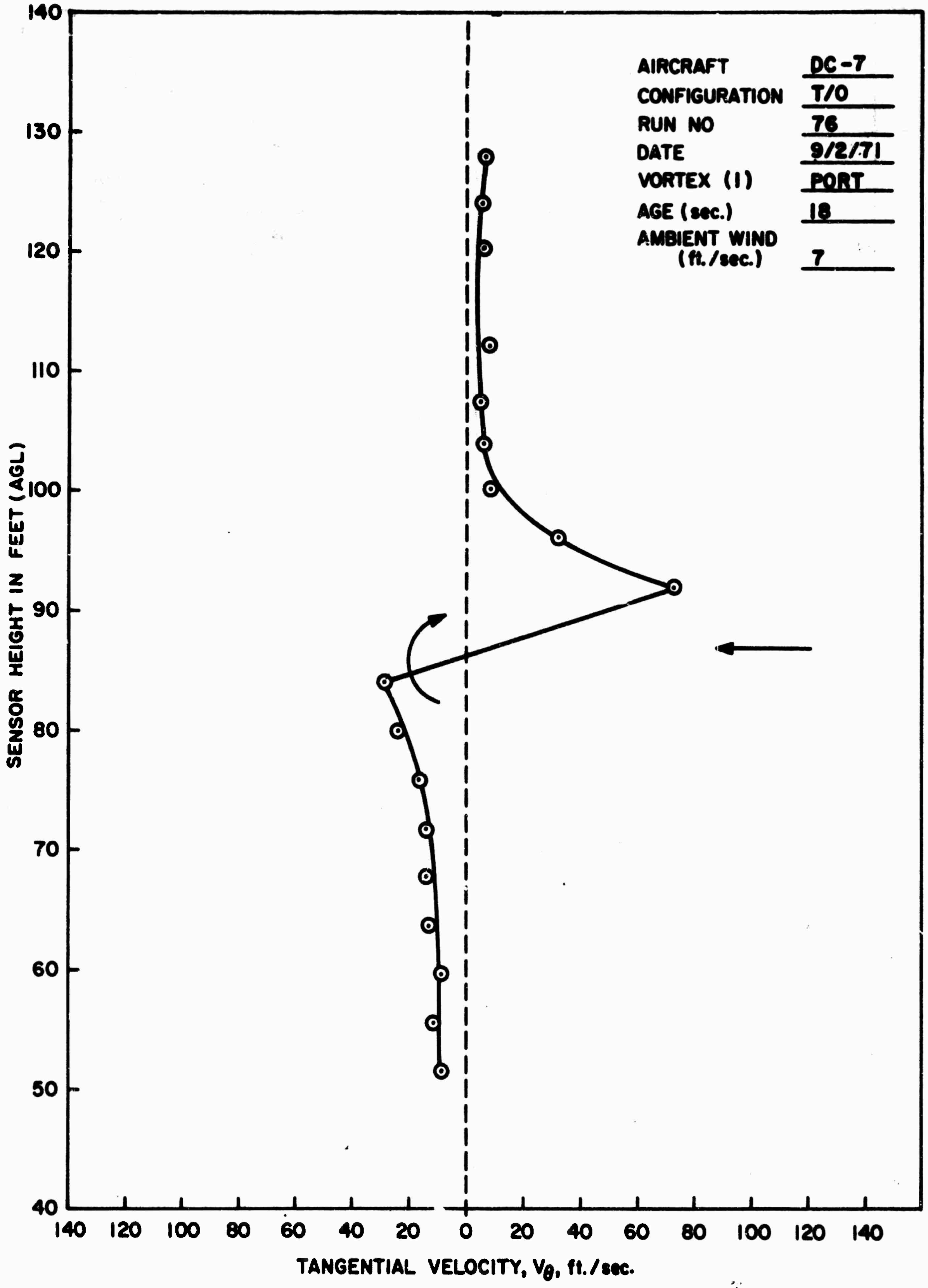
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 190
DATE 9/24/71
VORTEX (1) PORT
AGE (sec.) 17
AMBIENT WIND (ft./sec.) 24
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

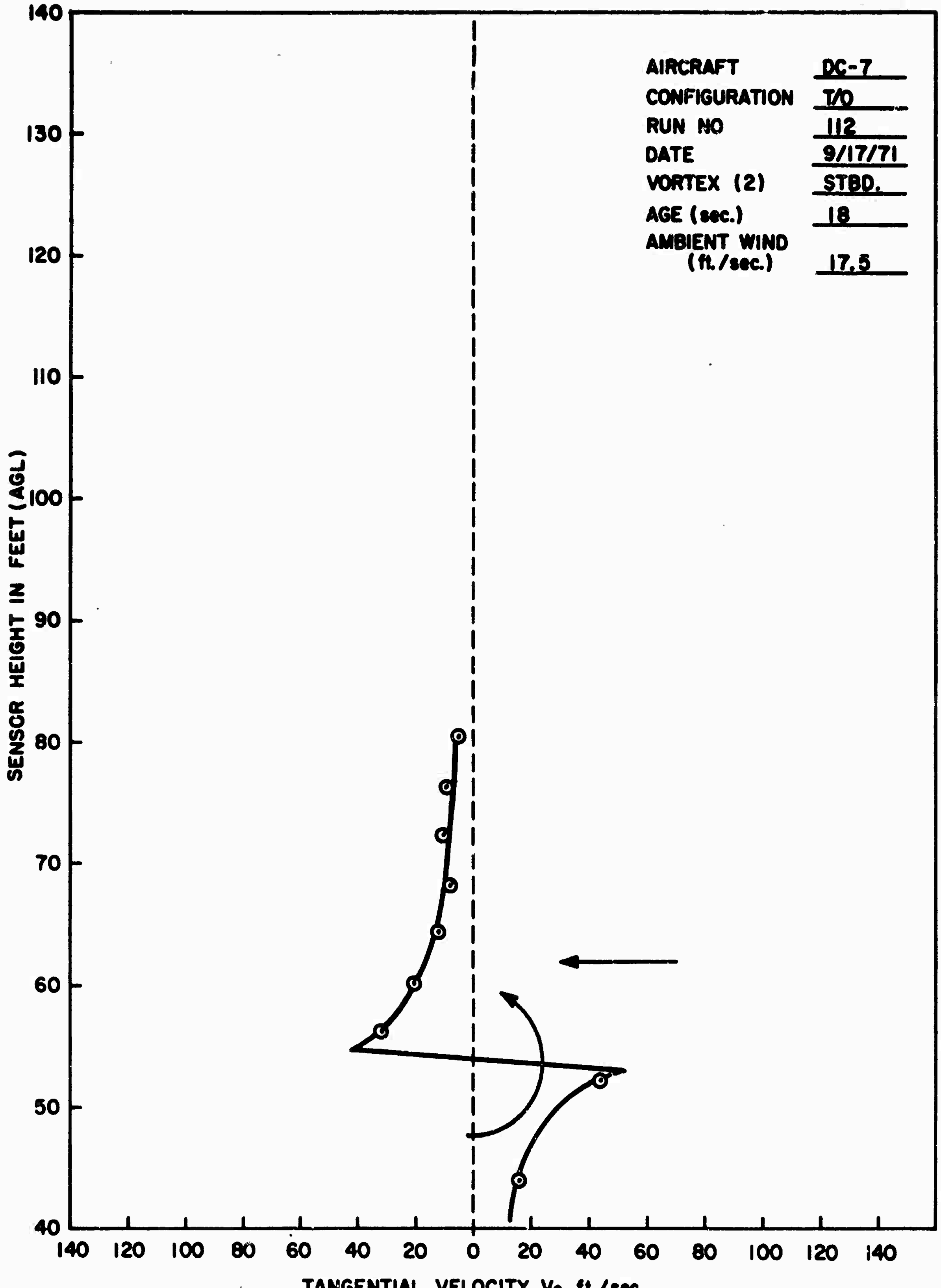

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 191
DATE 9/24/71
VORTEX (2) STBD.
AGE (sec.) 17
AMBIENT WIND (ft./sec.) 26
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, Vθ, ft./sec.



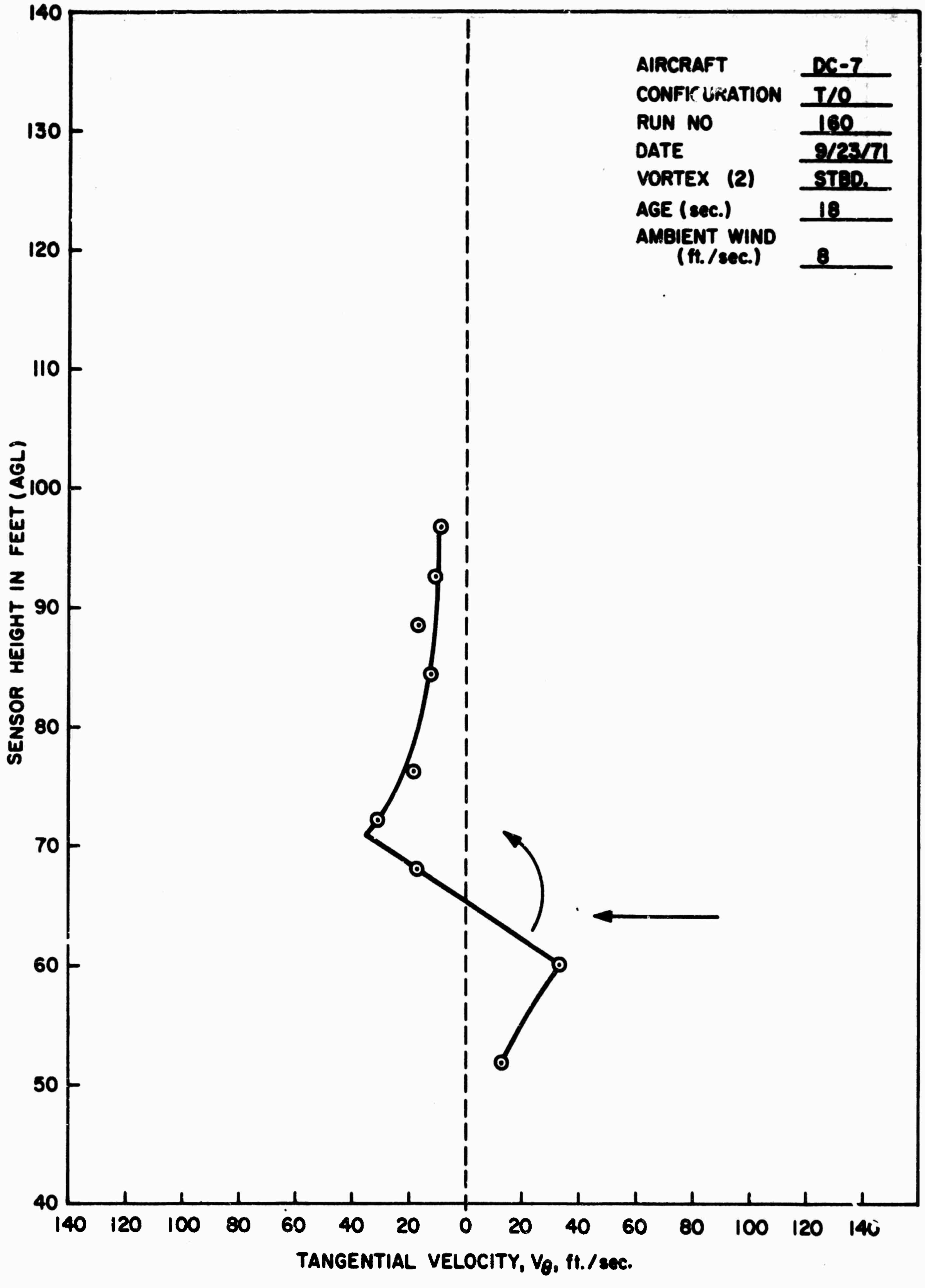
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 143
DATE 9/23/71
VORTEX (I) PORT
AGE (sec.) 17.5
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

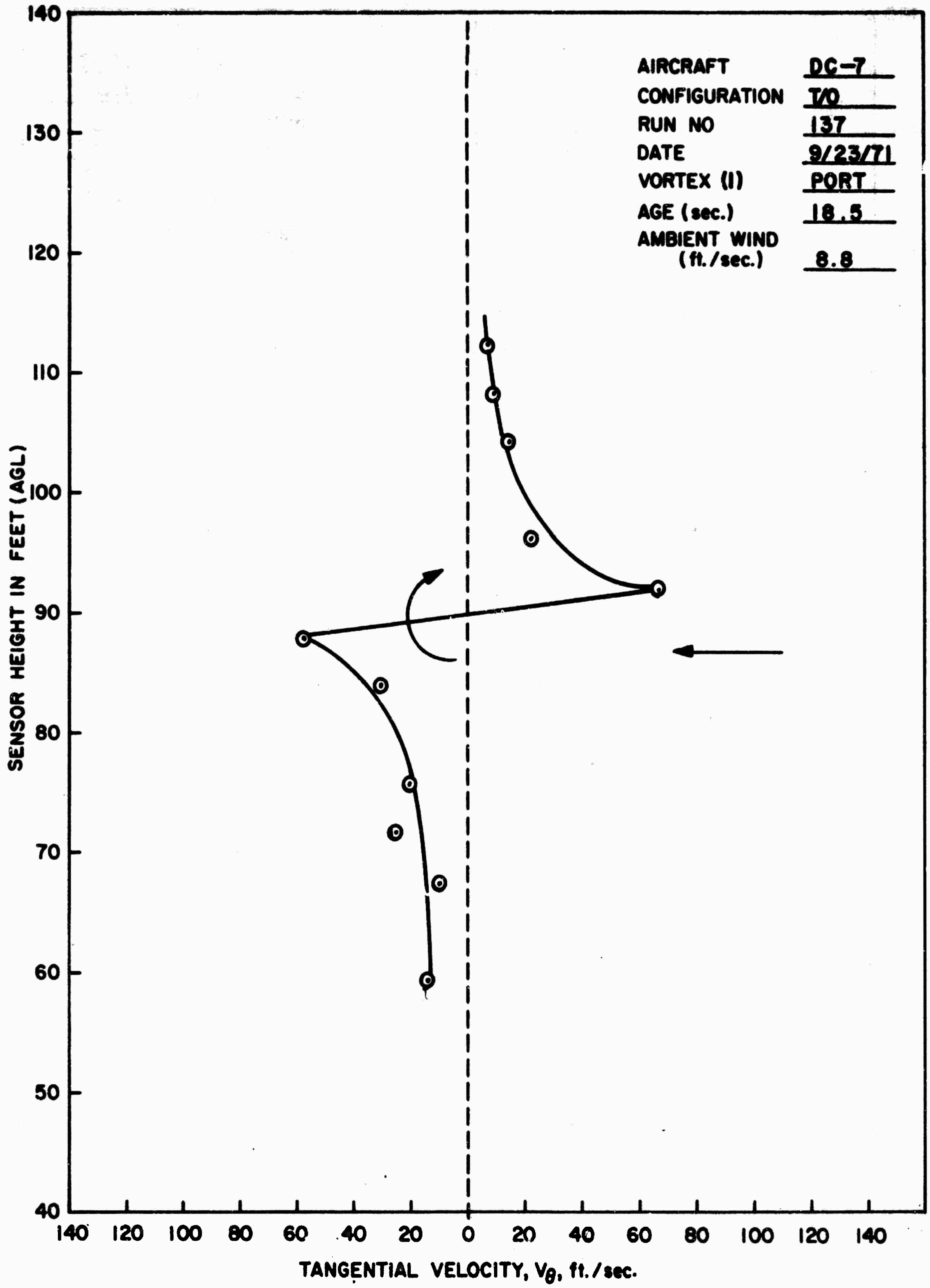

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 175
DATE 9/24/71
VORTEX (2) PORT
AGE (sec.) 17.5
AMBIENT WIND (ft./sec.) 17
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 76
DATE 9/2/71
VORTEX (1) PORT
AGE (sec.) 18
AMBIENT WIND (ft./sec.) 7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

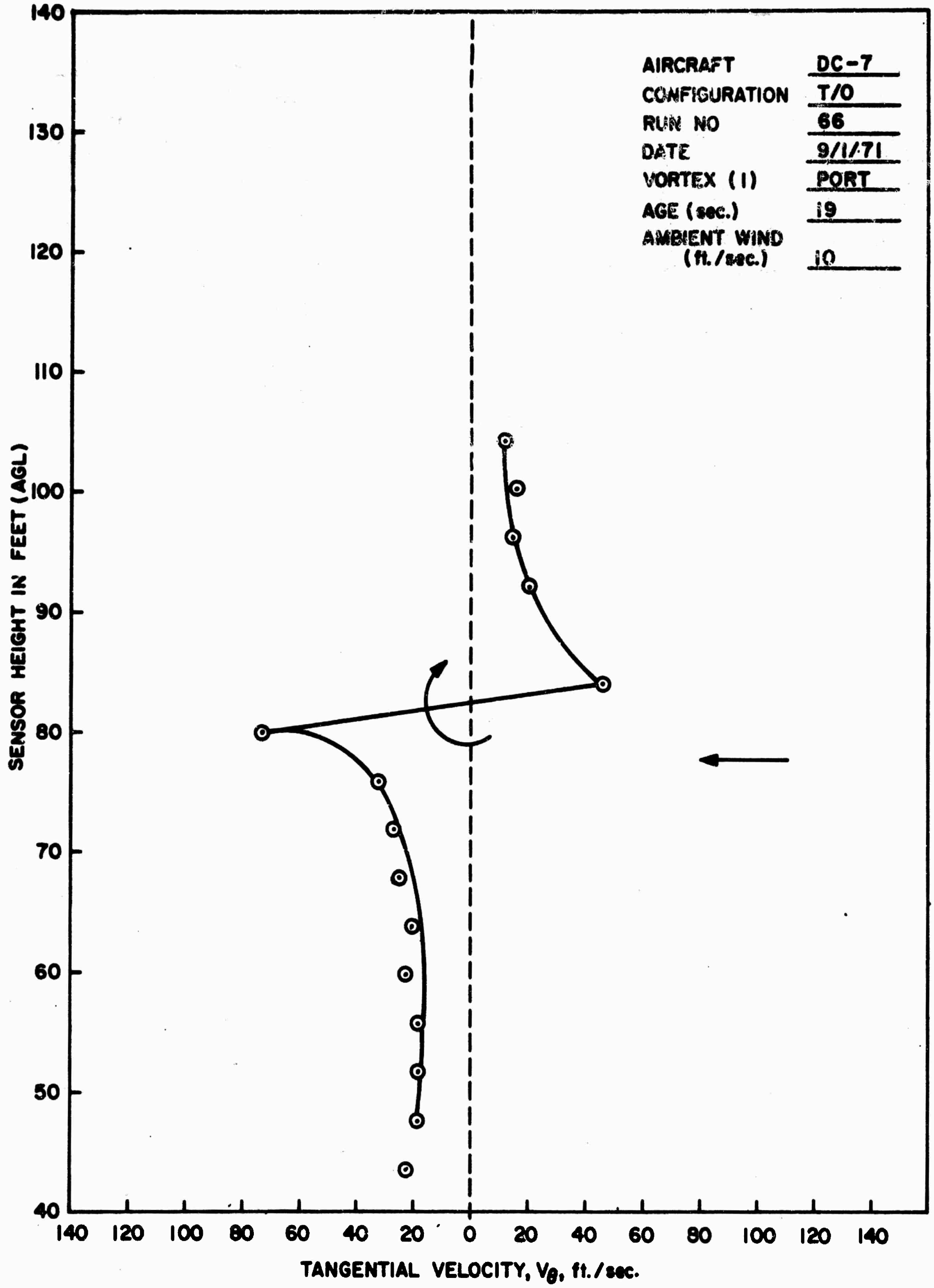


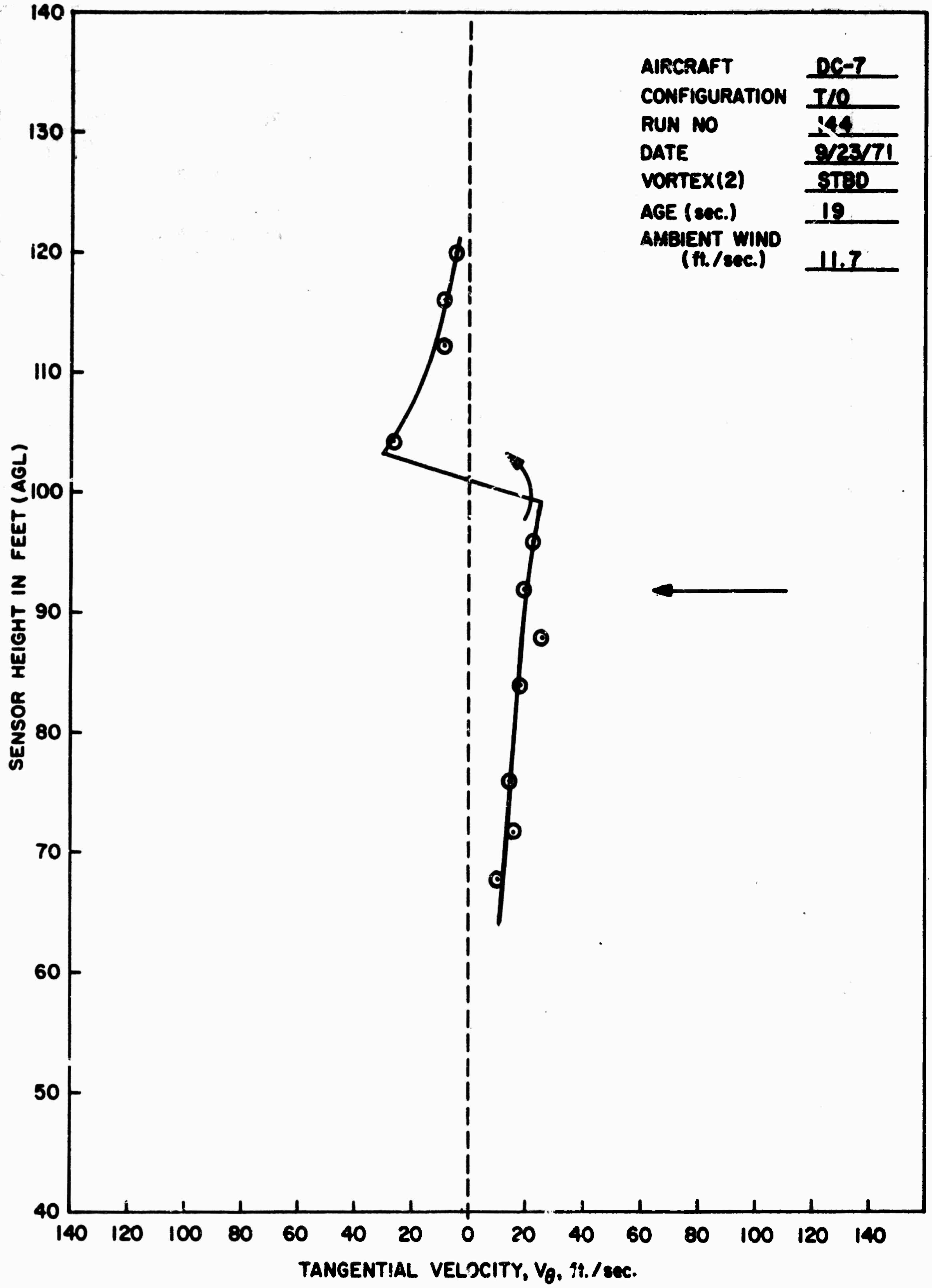
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 112
DATE 9/17/71
VORTEX (2) STBD.
AGE (sec.) 18
AMBIENT WIND (ft./sec.) 17.5
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 160
DATE 9/23/71
VORTEX (2) STBD.
AGE (sec.) 18
AMBIENT WIND (ft./sec.) 8
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

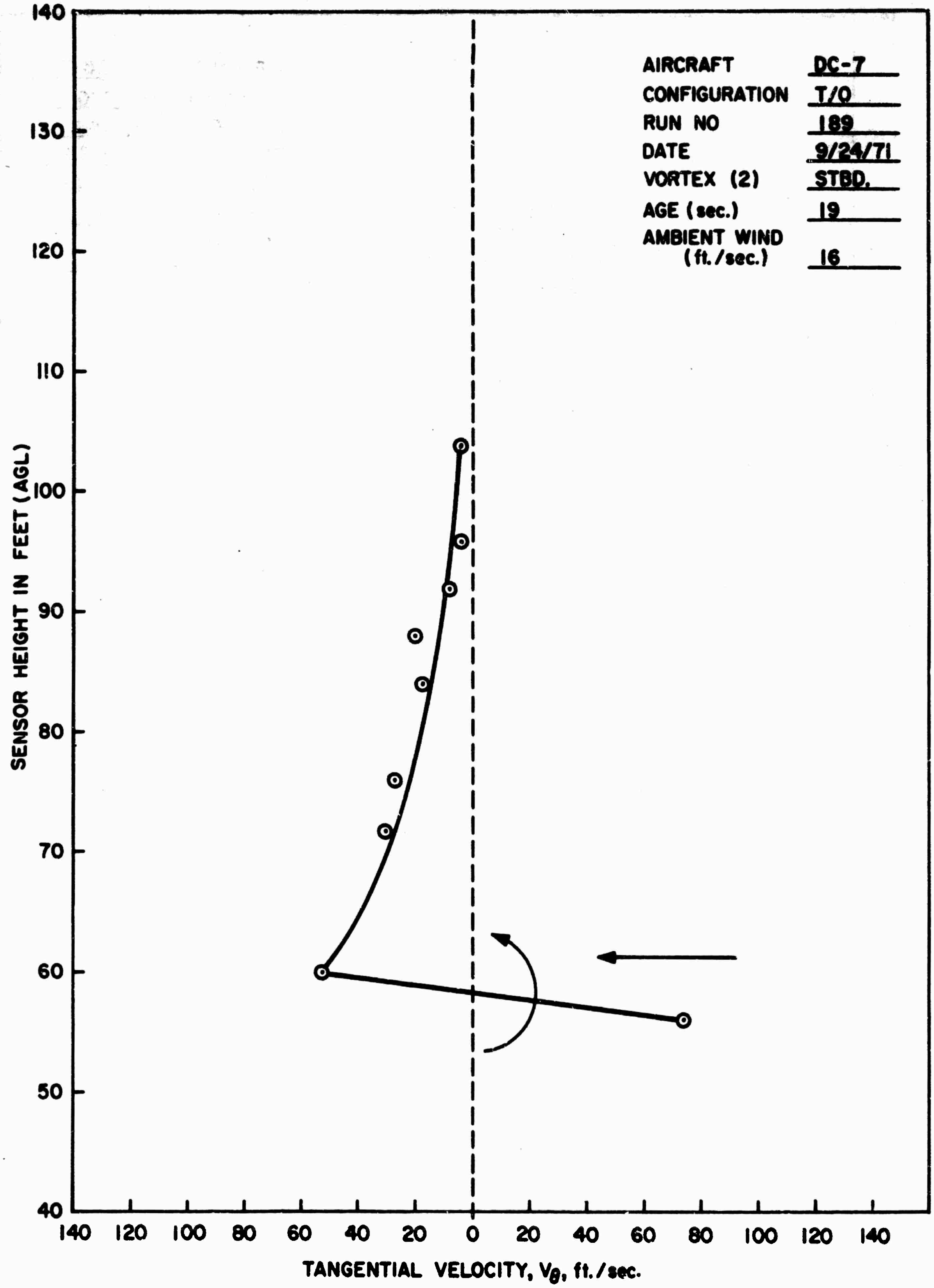


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 137
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 18.5
AMBIENT WIND (ft./sec.) 8.8
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

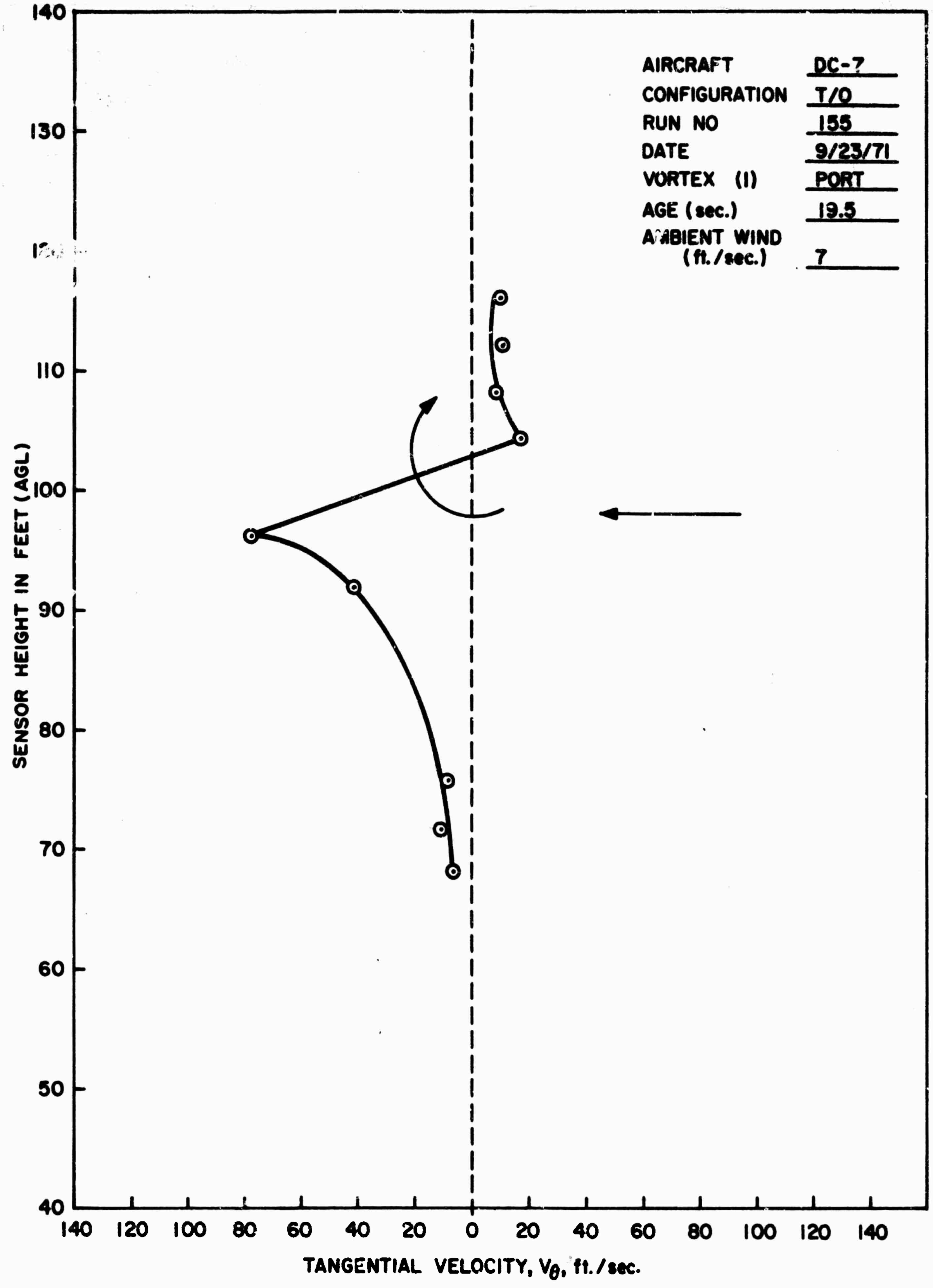

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 66
DATE 9/1/71
VORTEX (1) PORT
AGE (sec.) 19
AMBIENT WIND (ft./sec.) 10
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

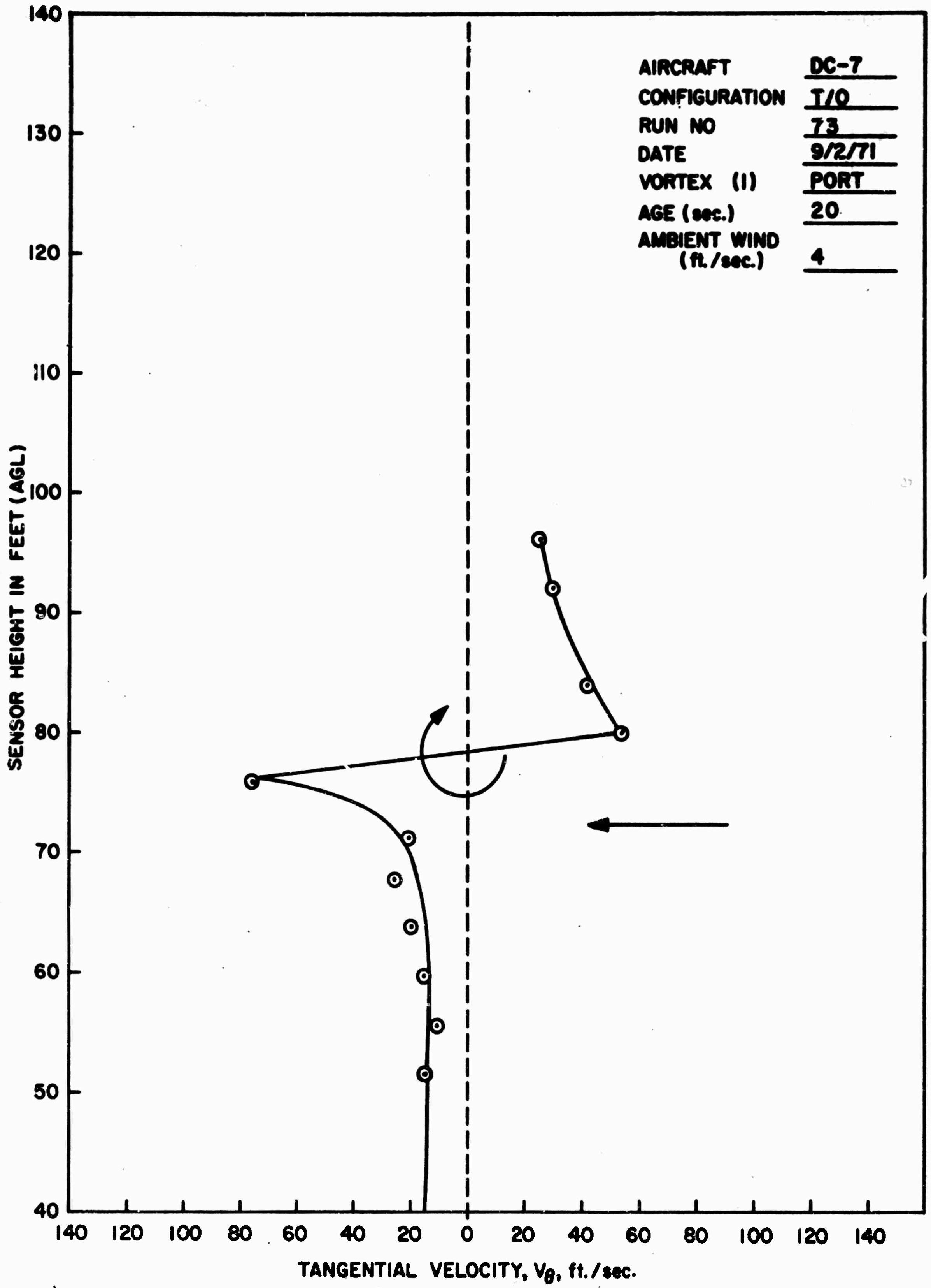


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 144
DATE 9/23/71
VORTEX(2) STBD
AGE (sec.) 19
AMBIENT WIND (ft./sec.) 11.7
140
130
120
110
100
90
80
70
60
50
40
SENSOR HEIGHT IN FEET (AGL)
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, Vθ, ft./sec.

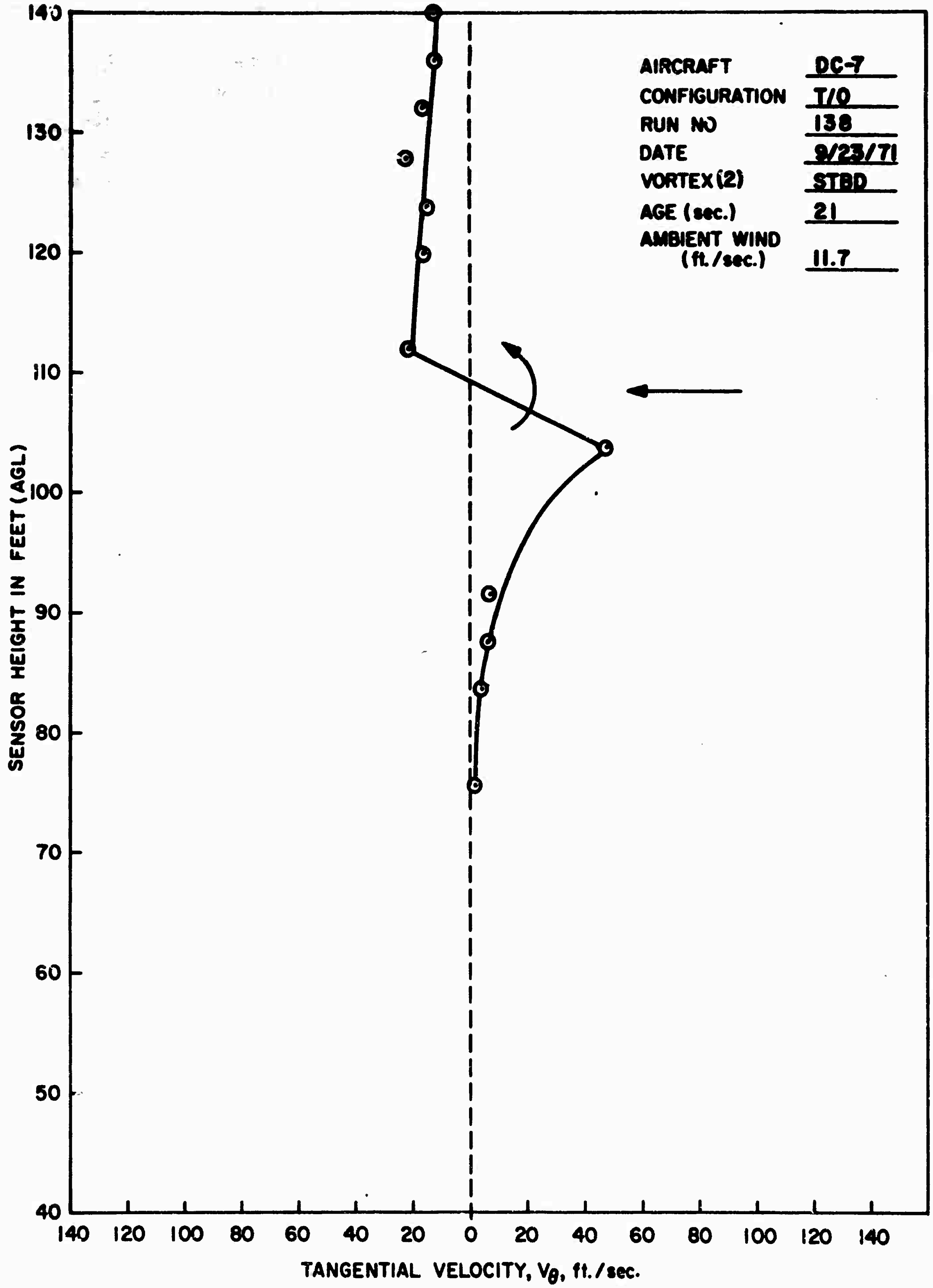


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 189
DATE 9/24/71
VORTEX (2) STBD.
AGE (sec.) 19
AMBIENT WIND (ft./sec.) 16
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

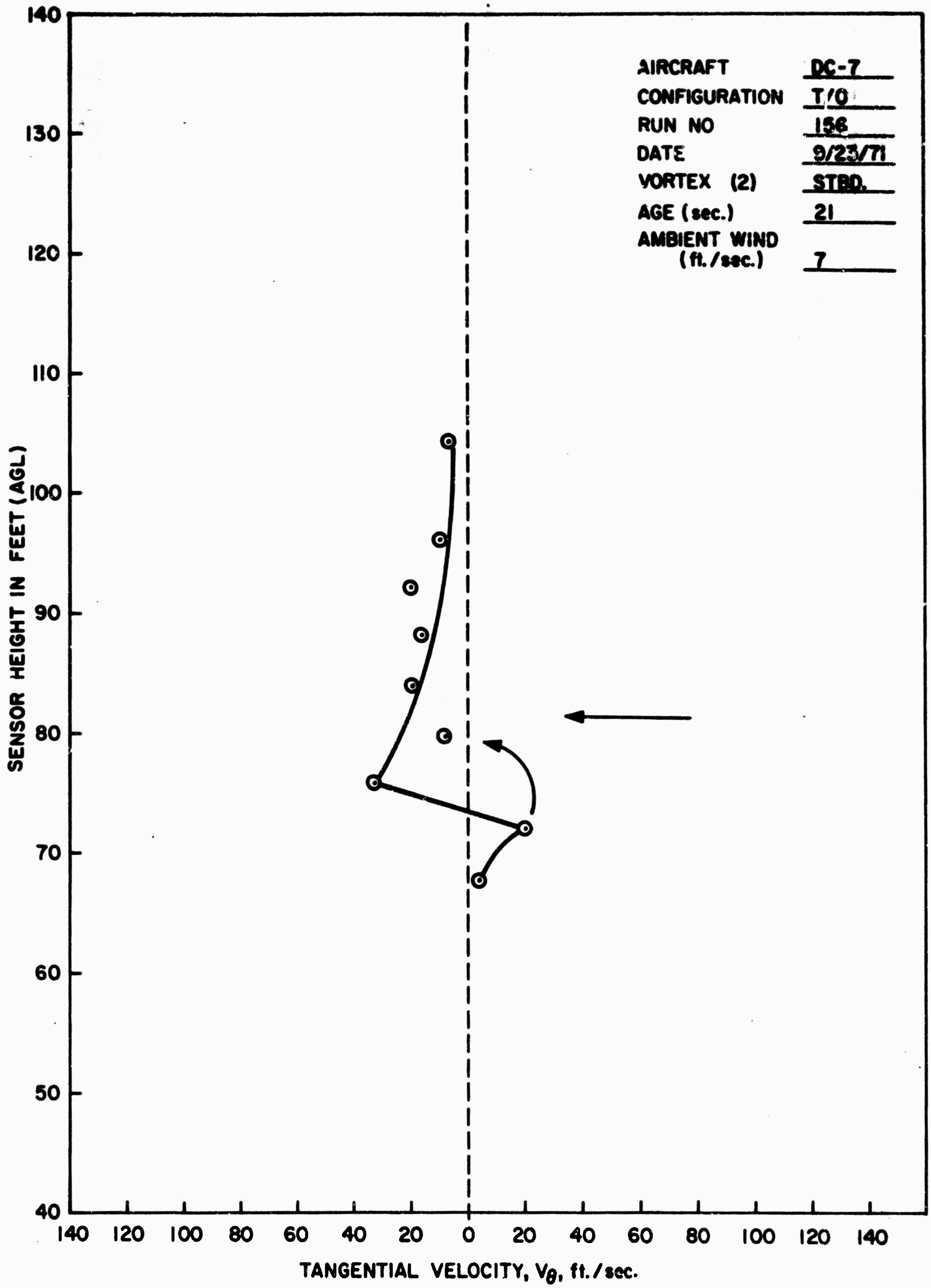

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 155
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 19.5
AMBIENT WIND (ft./sec.) 7
SENSOR HEIGHT IN FEET (AGL)
140
130
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



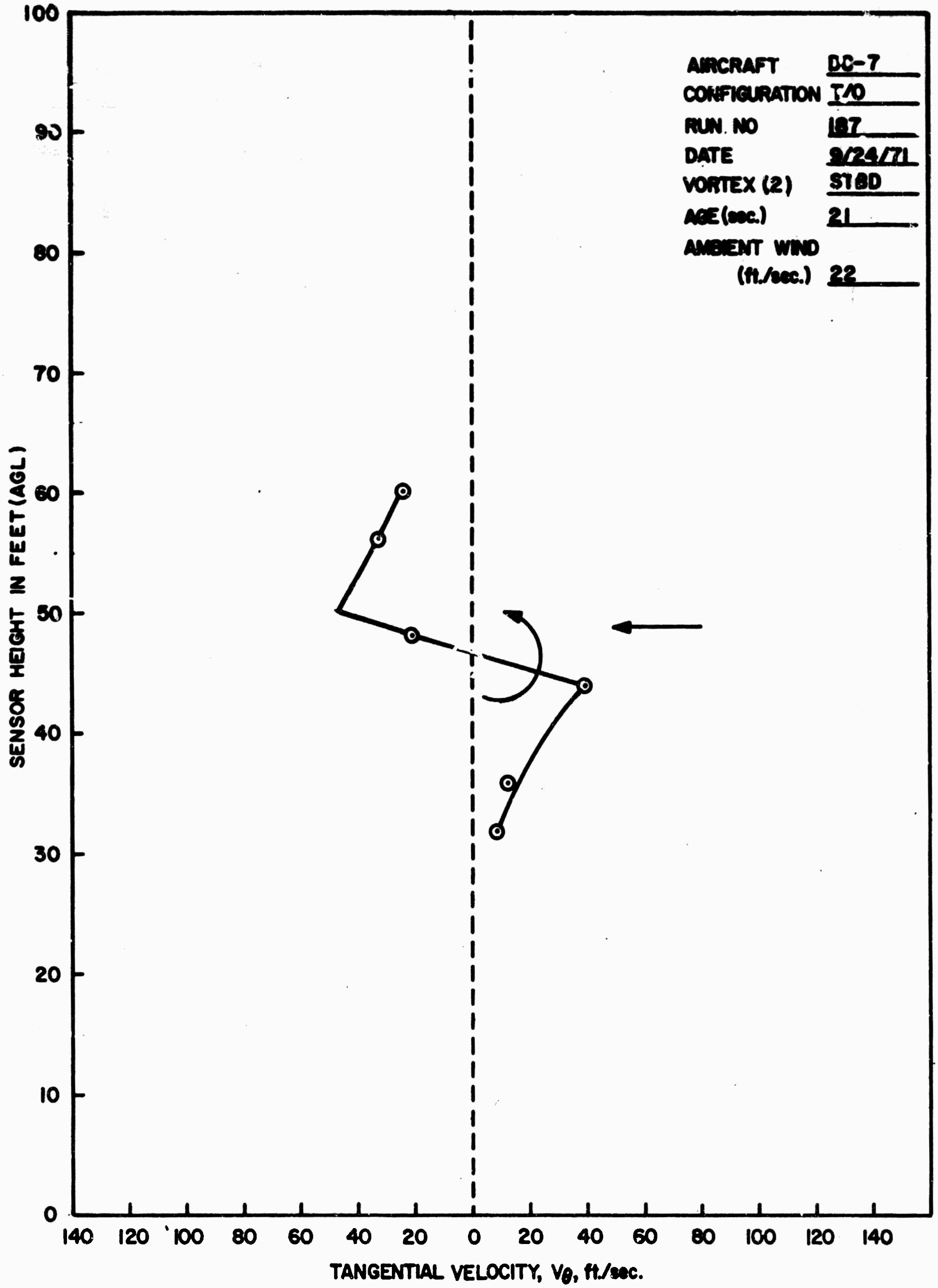
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 73
DATE 9/2/71
VORTEX (1) PORT
AGE (sec.) 20
AMBIENT WIND (ft./sec.) 4
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



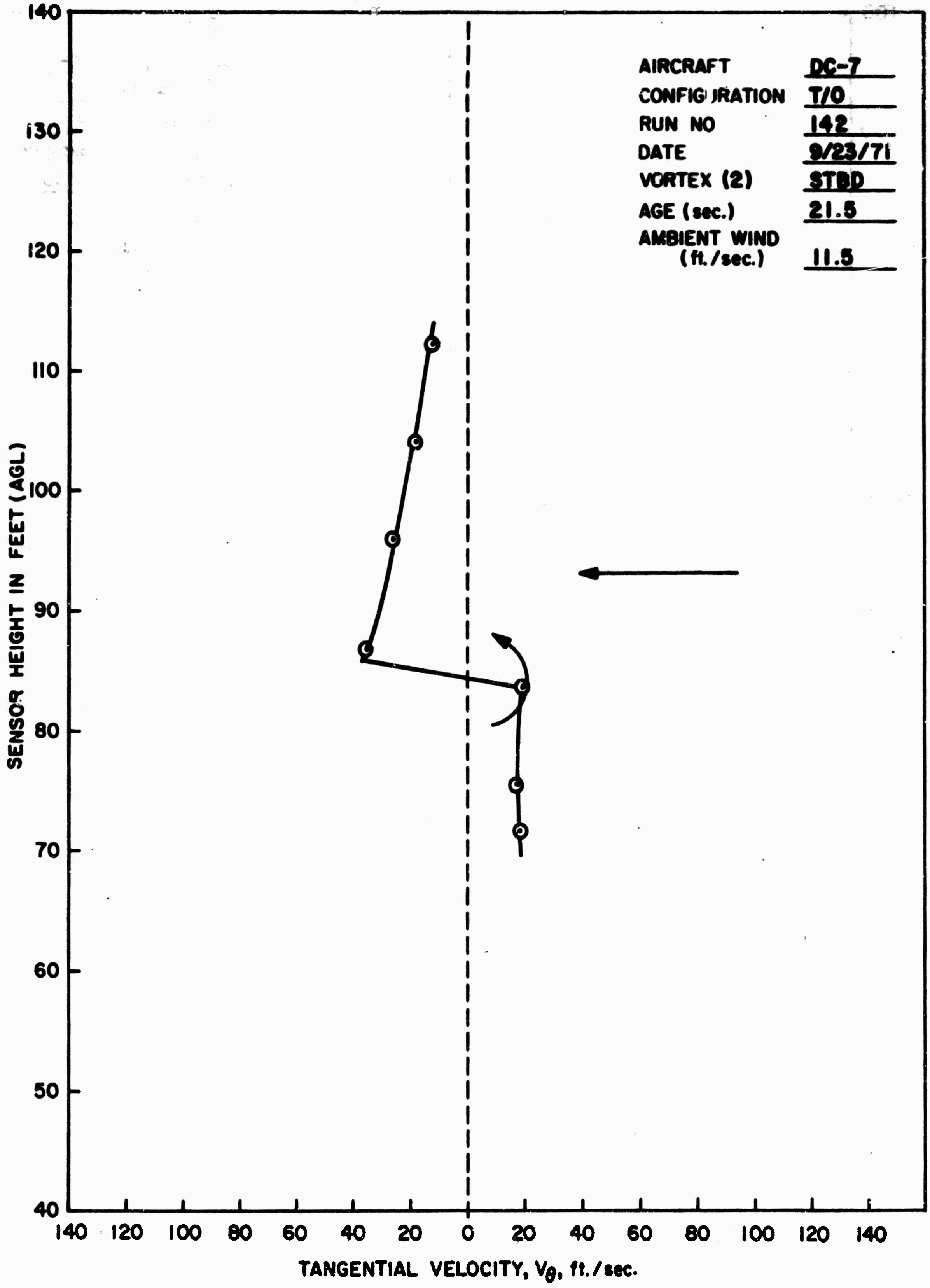
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 138
DATE 9/23/71
VORTEX (2) STBD
AGE (sec.) 21
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

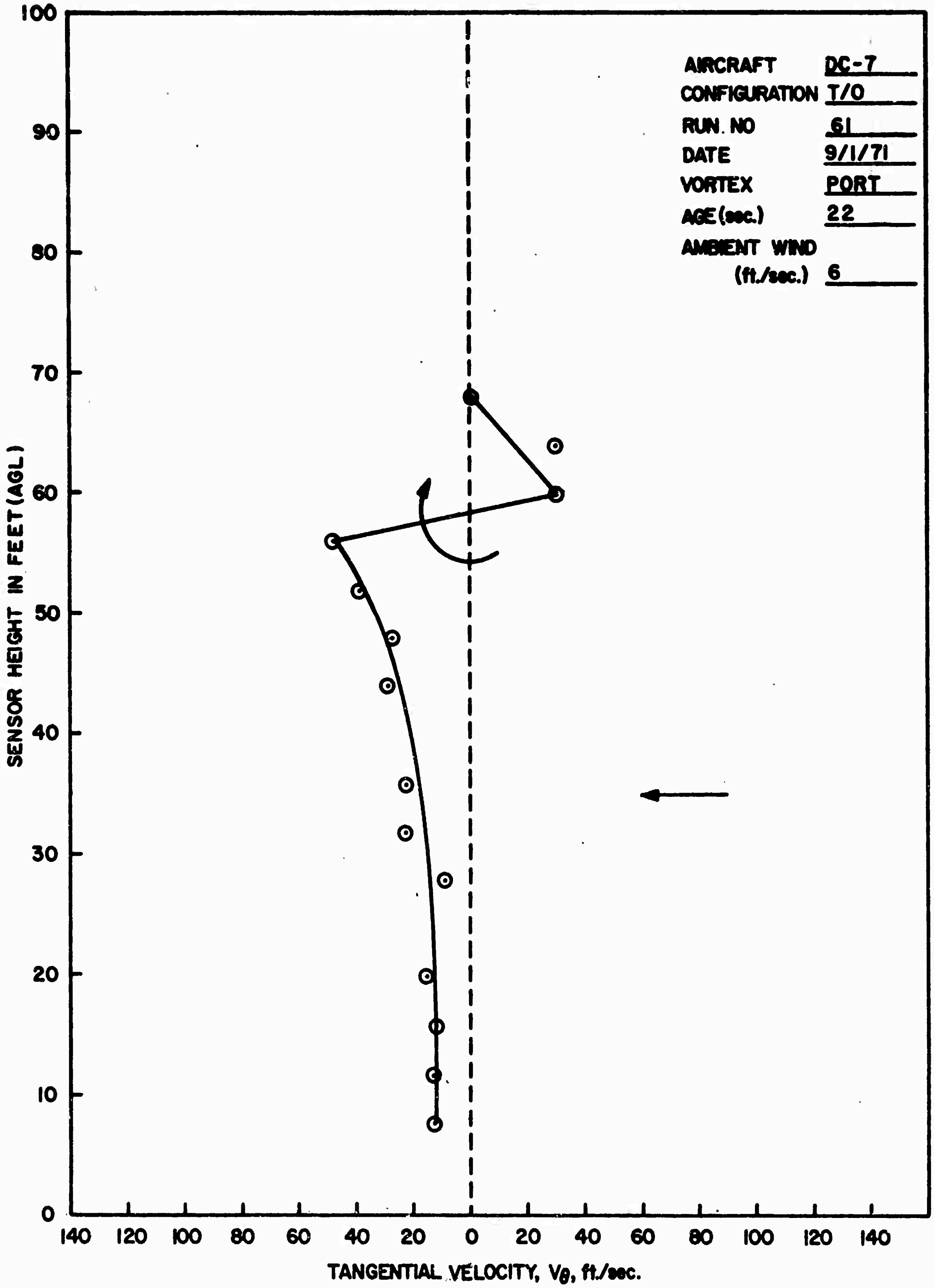


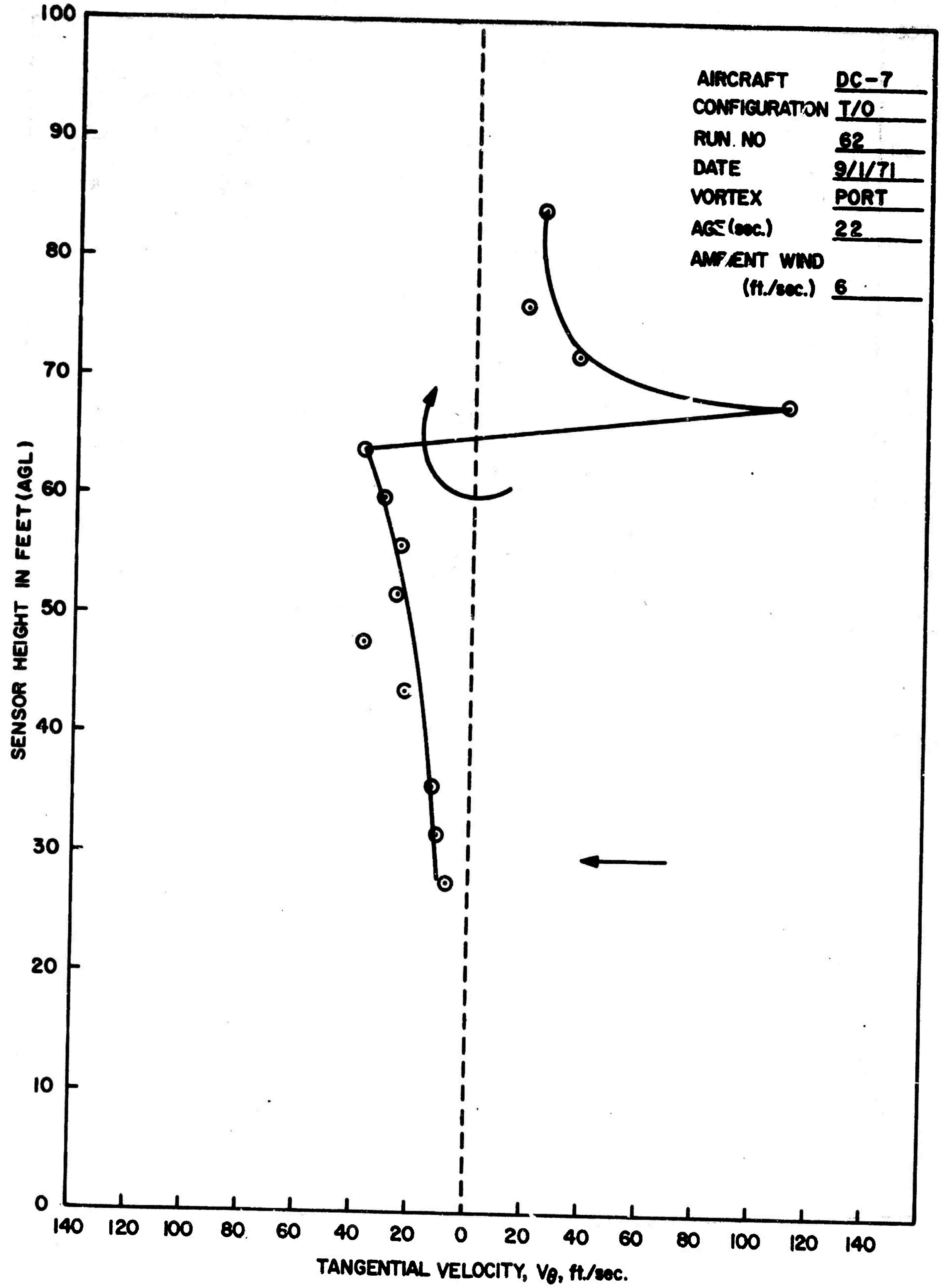
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 156
DATE 9/23/71
VORTEX (2) STBD.
AGE (sec.) 21
AMBIENT WIND (ft./sec.) 7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



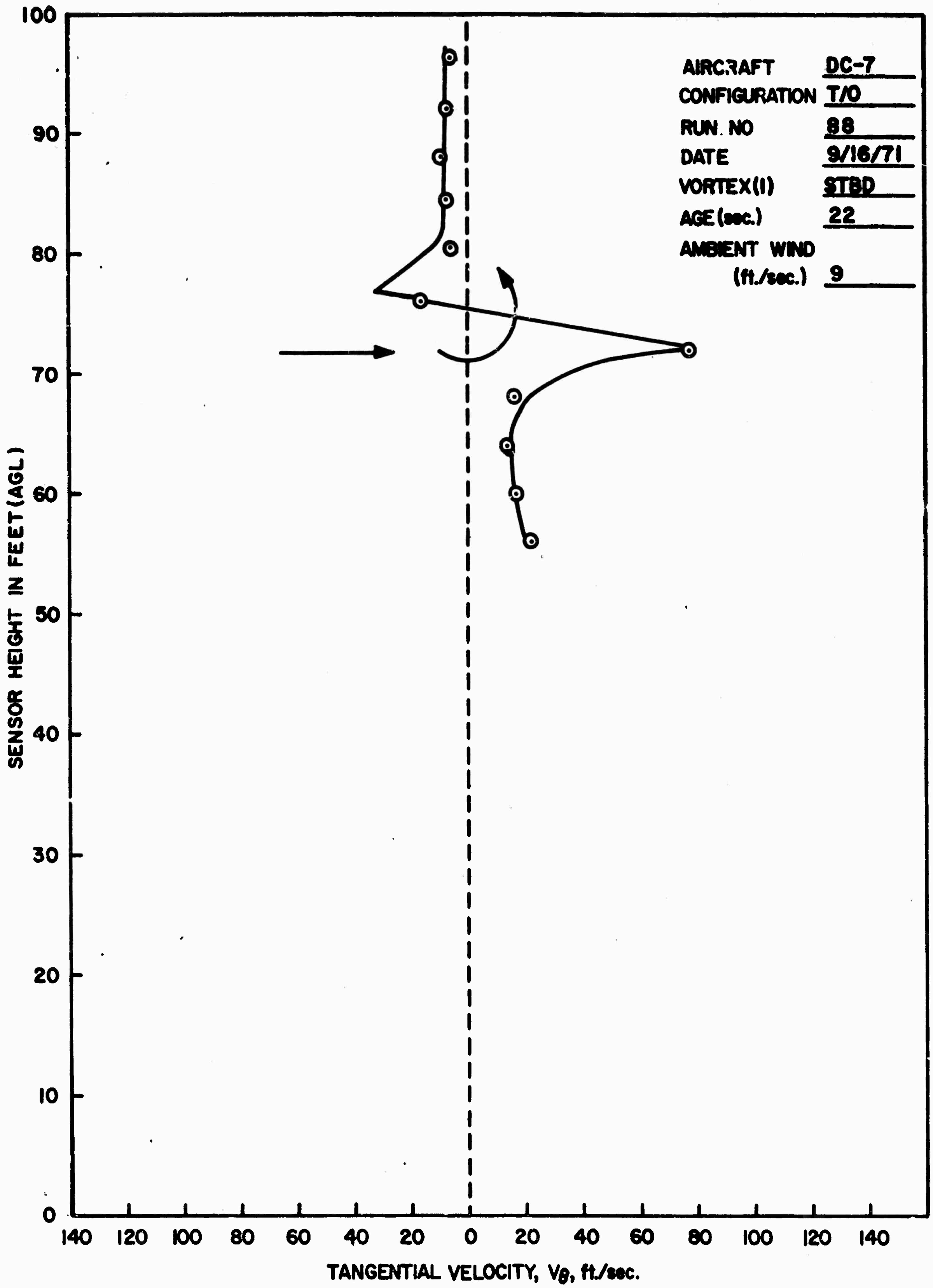
AIRCRAFT DC-7
CONFIGURATION T/O
RUN. NO 187
DATE 9/24/71
VORTEX (2) STBD
AGE (sec.) 21
AMBIENT WIND (ft./sec.) 22
SENSOR HEIGHT IN FEET (AGL)
100
90
80
70
60
50
40
30
20
10
0
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 142
DATE 9/23/71
VORTEX (2) STBD
AGE (sec.) 21.5
AMBIENT WIND (ft./sec.) 11.5
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

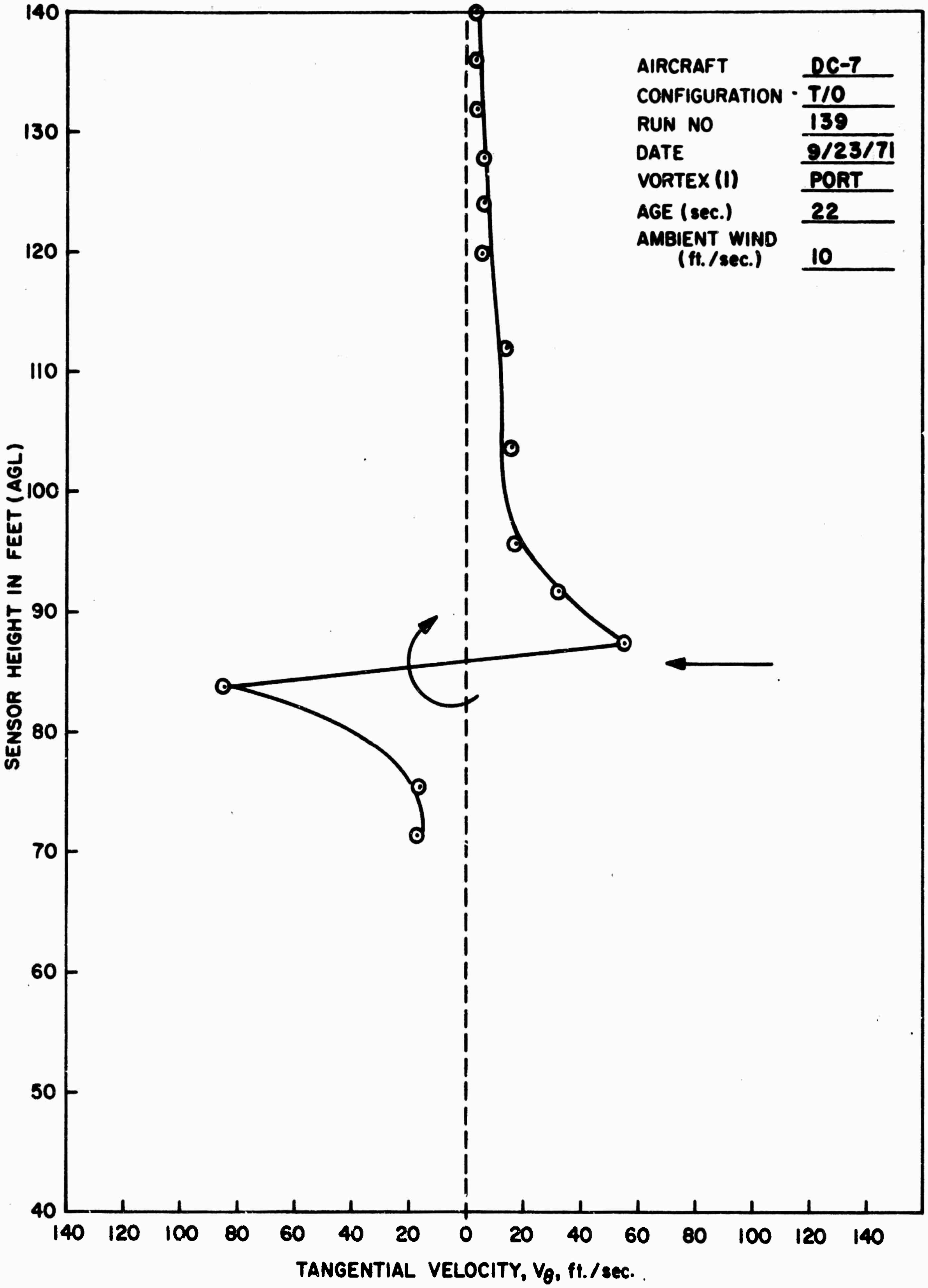

AIRCRAFT DC-7
CONFIGURATION T/O
RUN. NO 61
DATE 9/1/71
VORTEX PORT
AGE (sec.) 22
AMBIENT WIND (ft./sec.) 6
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
0
10
20
30
40
50
60
70
80
90
100
140
120
100
80
60
40
20
0
20
40
60
80
100
120
140

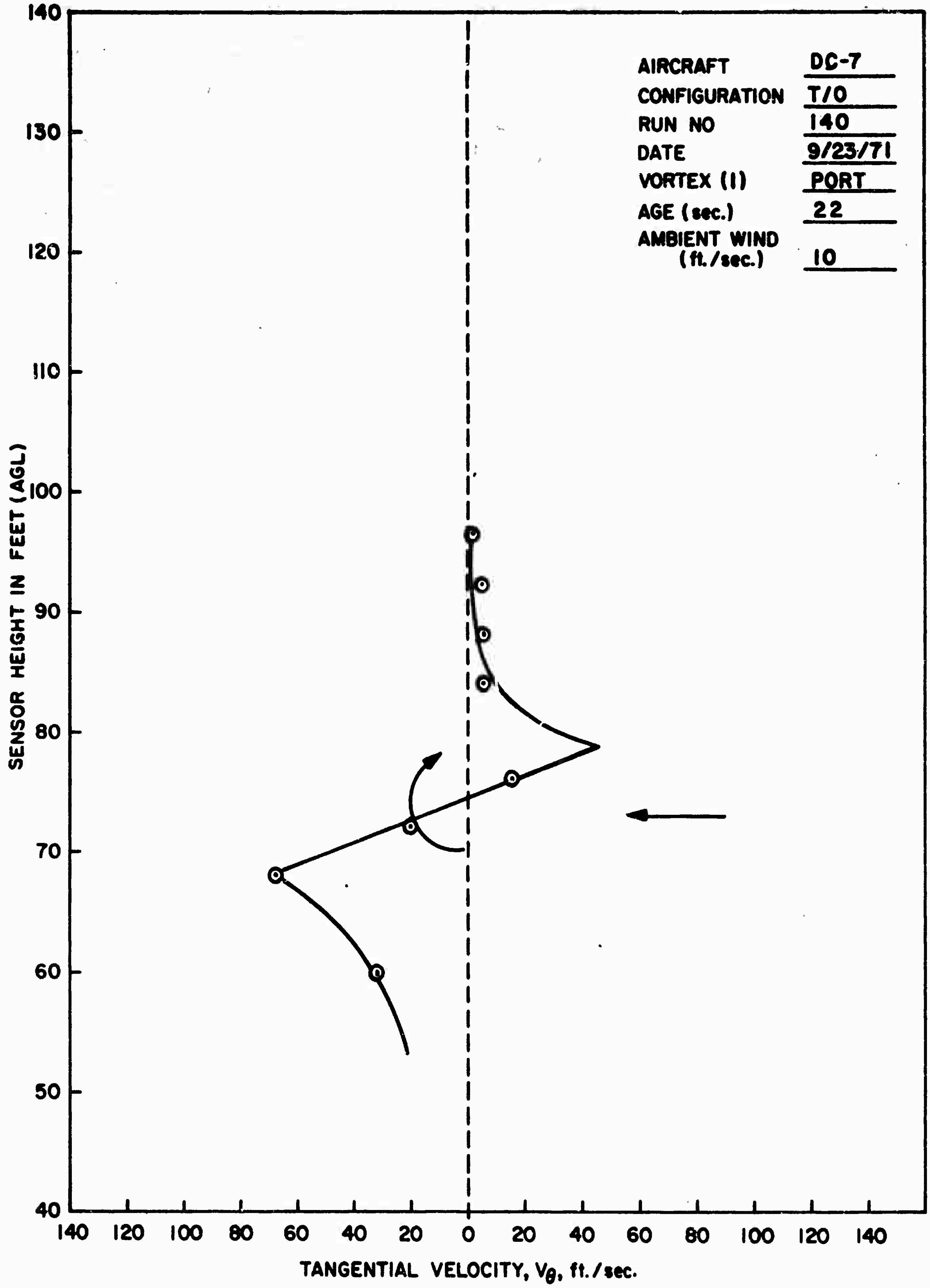


AIRCRAFT DC-7
CONFIGURATION T/O
RUN. NO 62
DATE 9/1/71
VORTEX PORT
AGE (sec.) 22
AMBIENT WIND (ft./sec.) 6
SENSOR HEIGHT IN FEET (AGL)
100
90
80
70
60
50
40
30
20
10
0
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

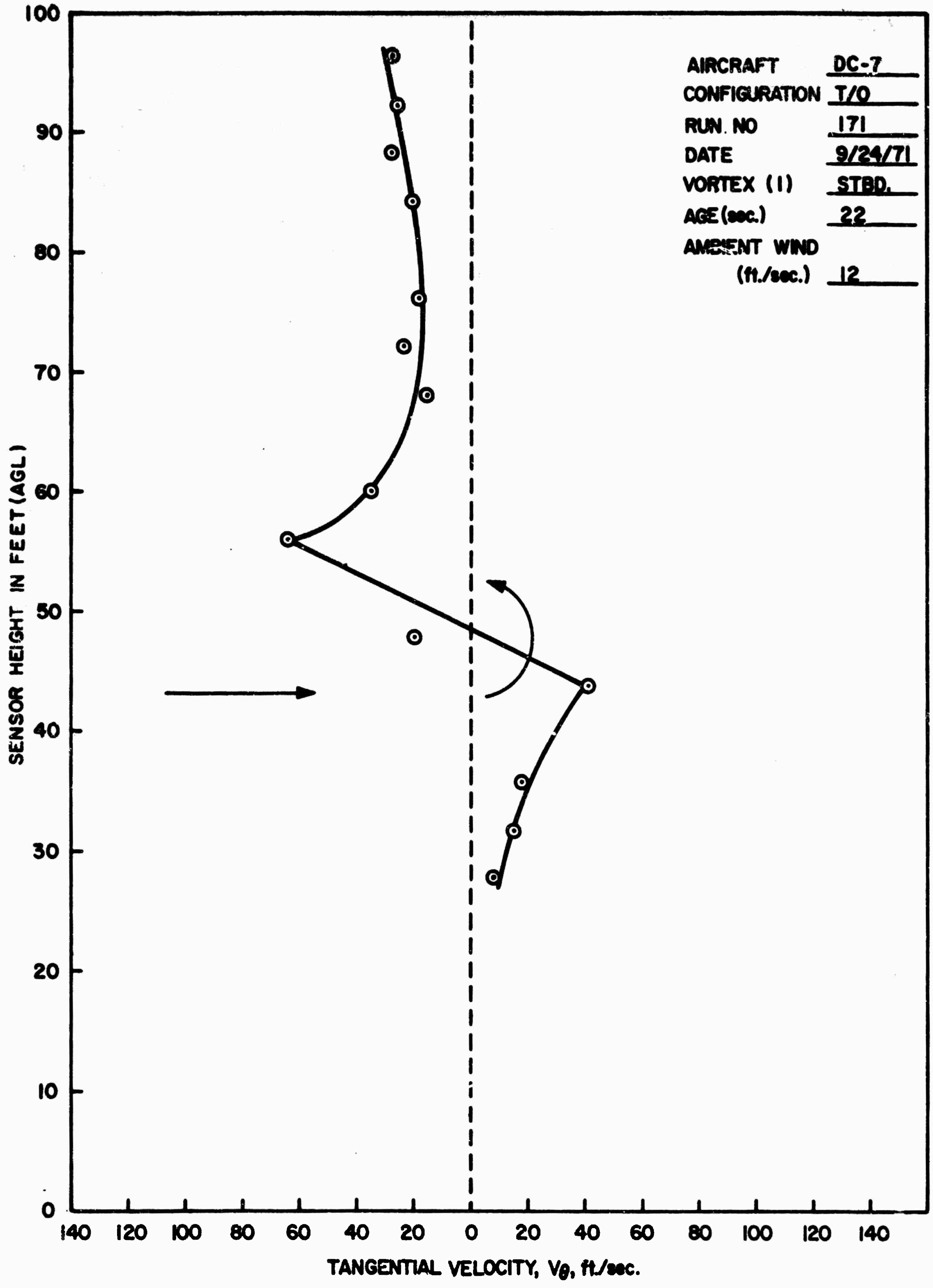


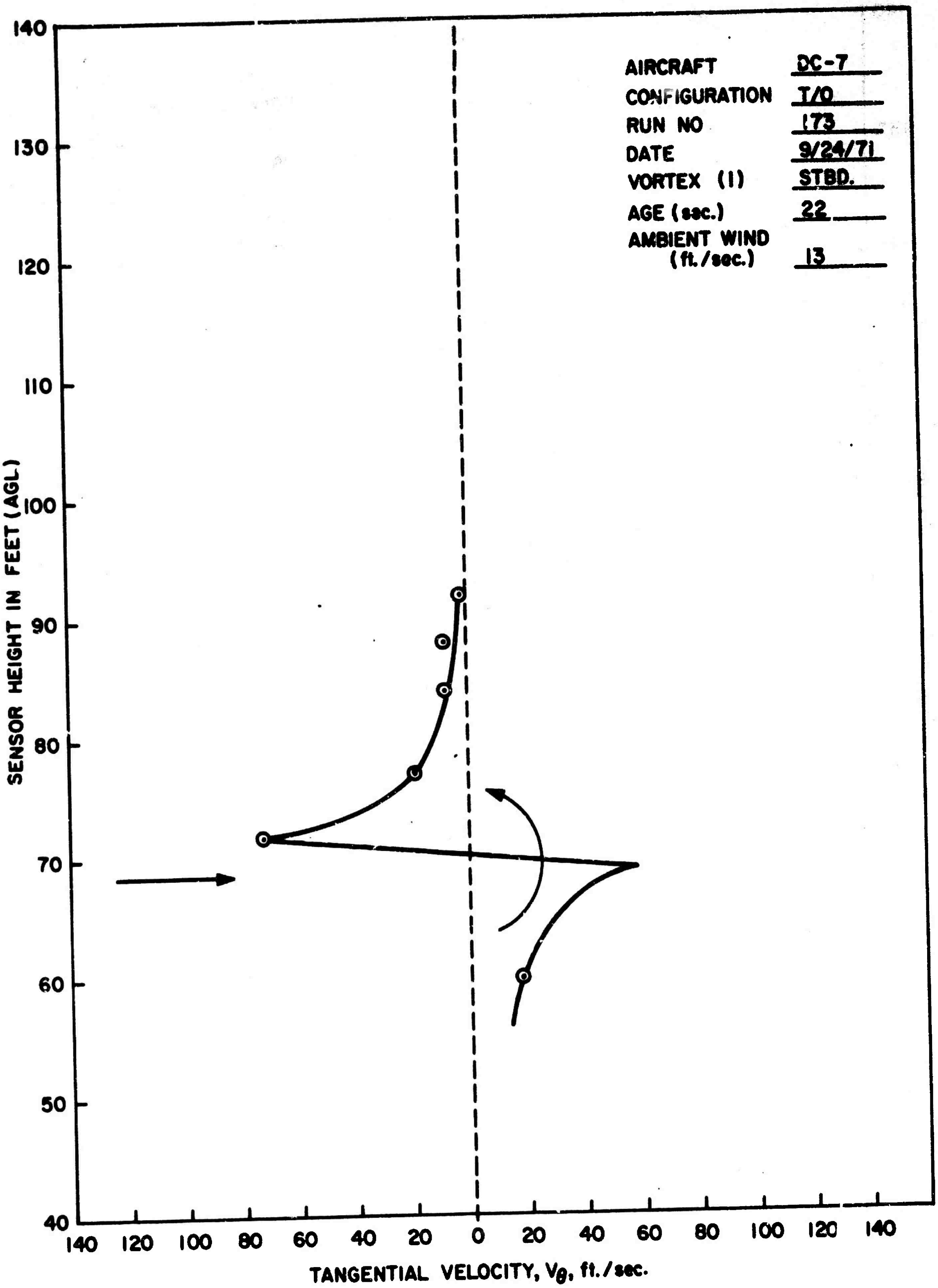
AIRCRAFT DC-7
CONFIGURATION T/O
RUN. NO 88
DATE 9/16/71
VORTEX(1) STBD
AGE (sec.) 22
AMBIENT WIND (ft./sec.) 9
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
100
90
80
70
60
50
40
30
20
10
0
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 139
DATE 9/23/71
VORTEX (I) PORT
AGE (sec.) 22
AMBIENT WIND (ft./sec.) 10
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

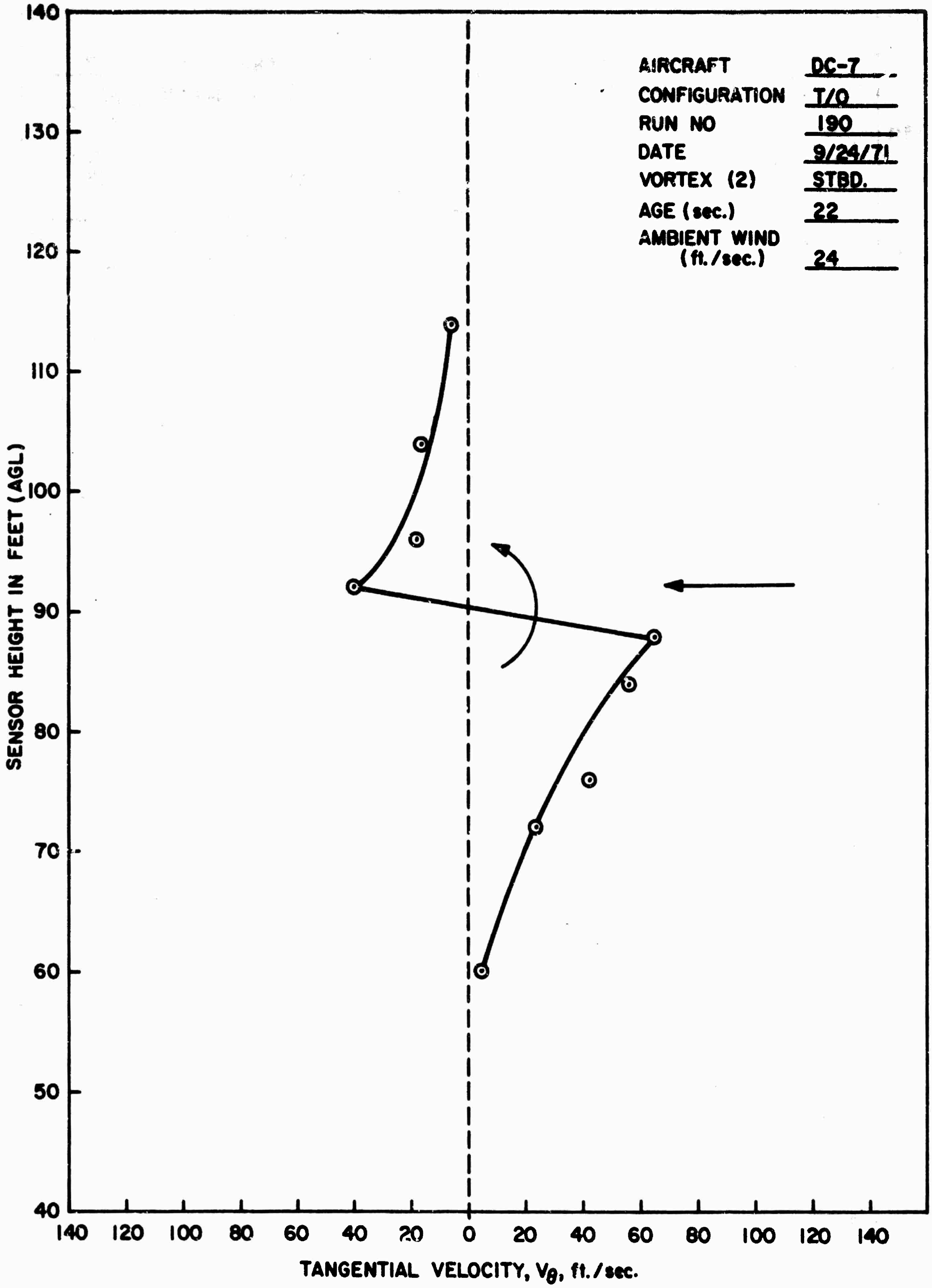


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 140
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 22
AMBIENT WIND (ft./sec.) 10
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

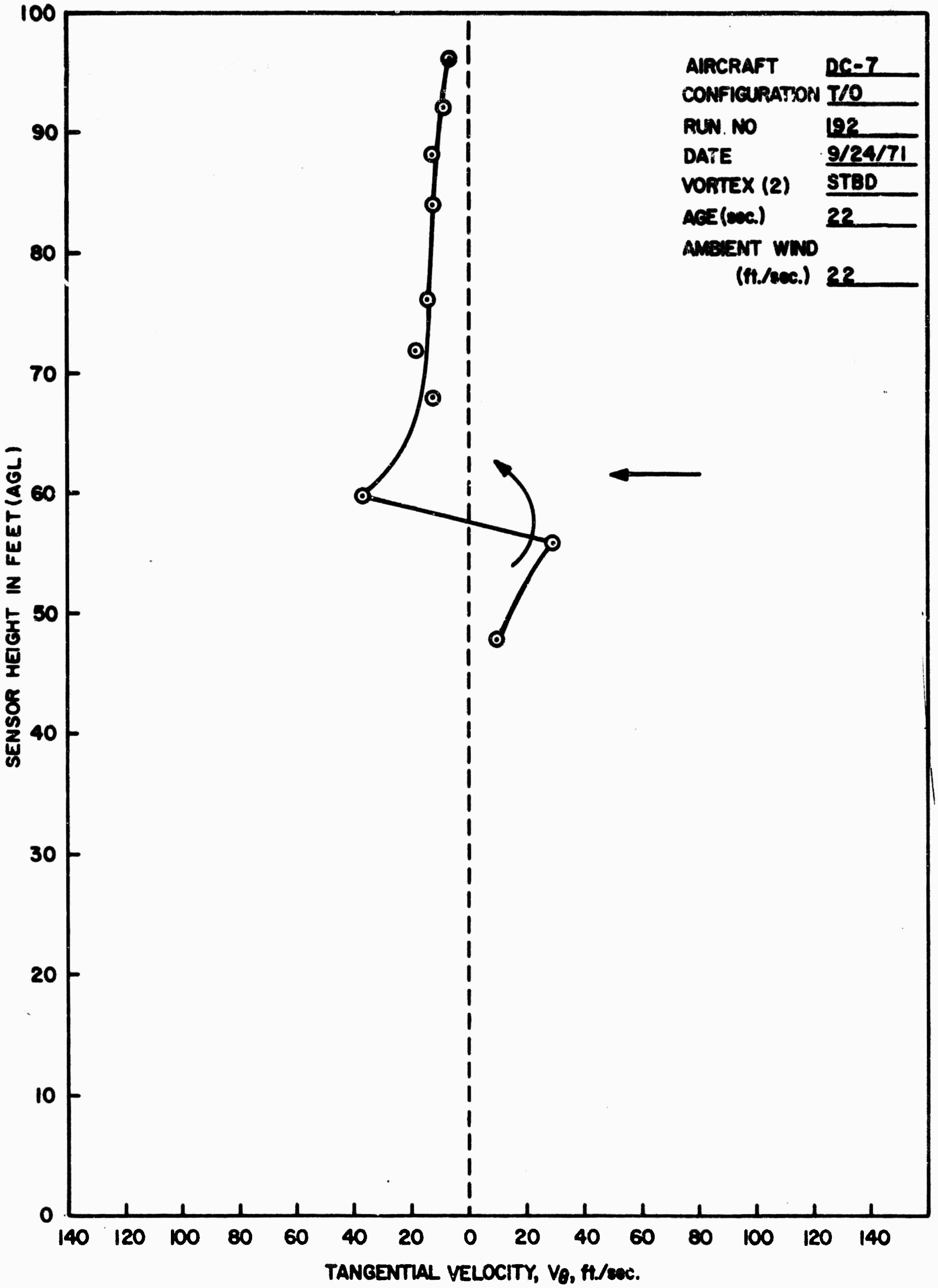

AIRCRAFT DC-7
CONFIGURATION T/O
RUN. NO 171
DATE 9/24/71
VORTEX (1) STBD.
AGE (sec.) 22
AMBIENT WIND (ft./sec.) 12
SENSOR HEIGHT IN FEET (AGL)
100
90
80
70
60
50
40
30
20
10
0
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



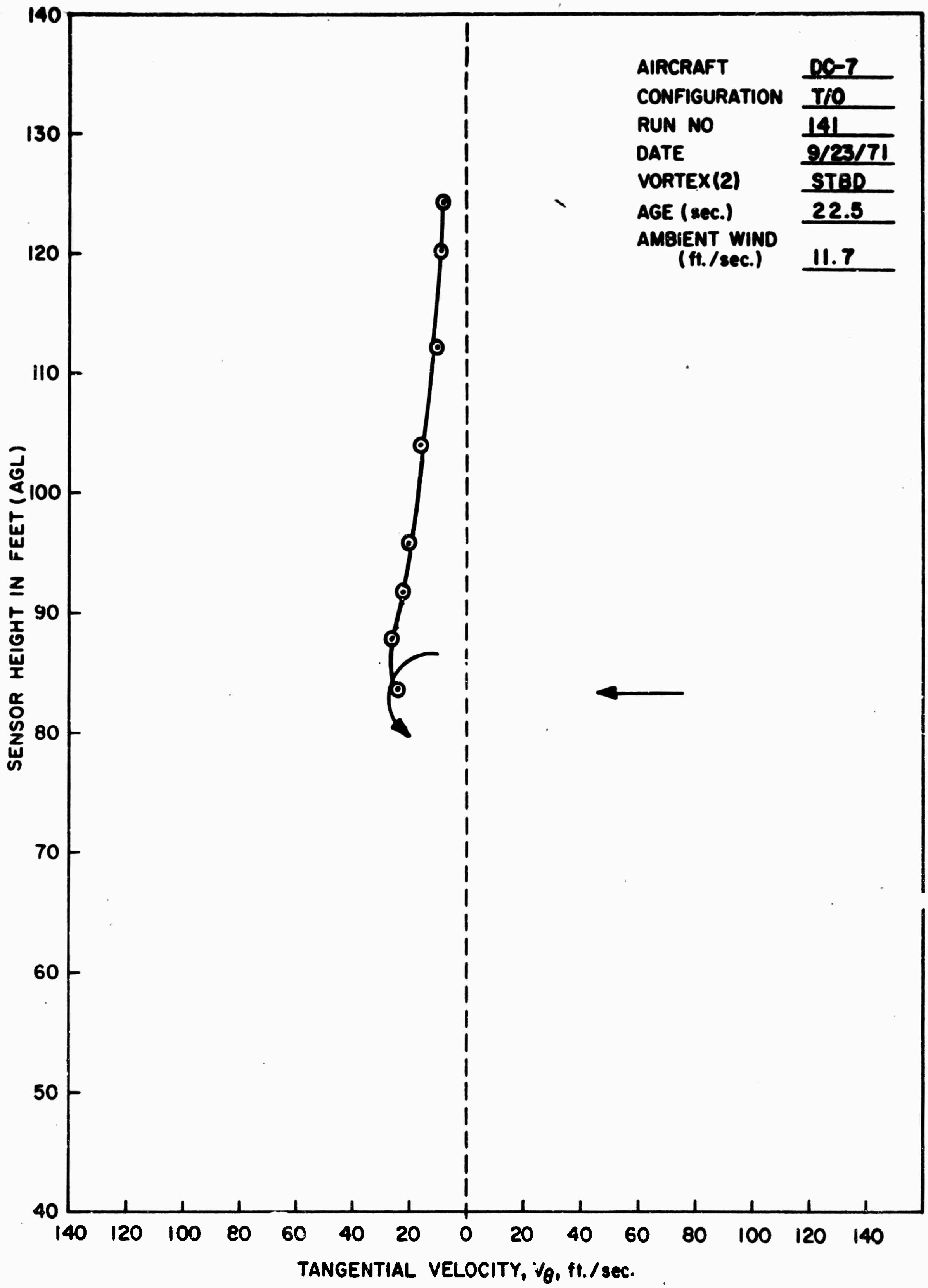
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 173
DATE 9/24/71
VORTEX (1) STBD.
AGE (sec.) 22
AMBIENT WIND (ft./sec.) 13
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

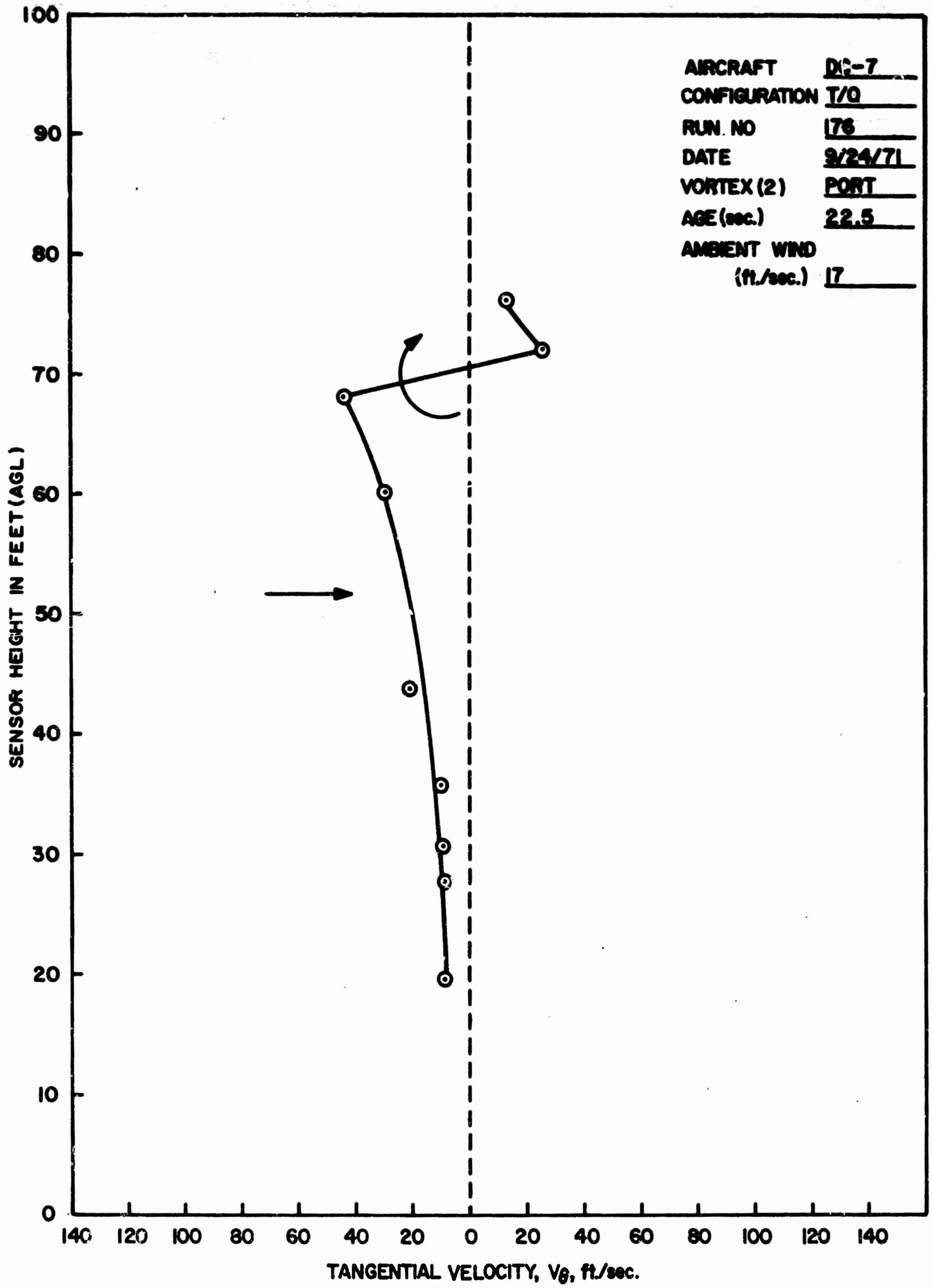


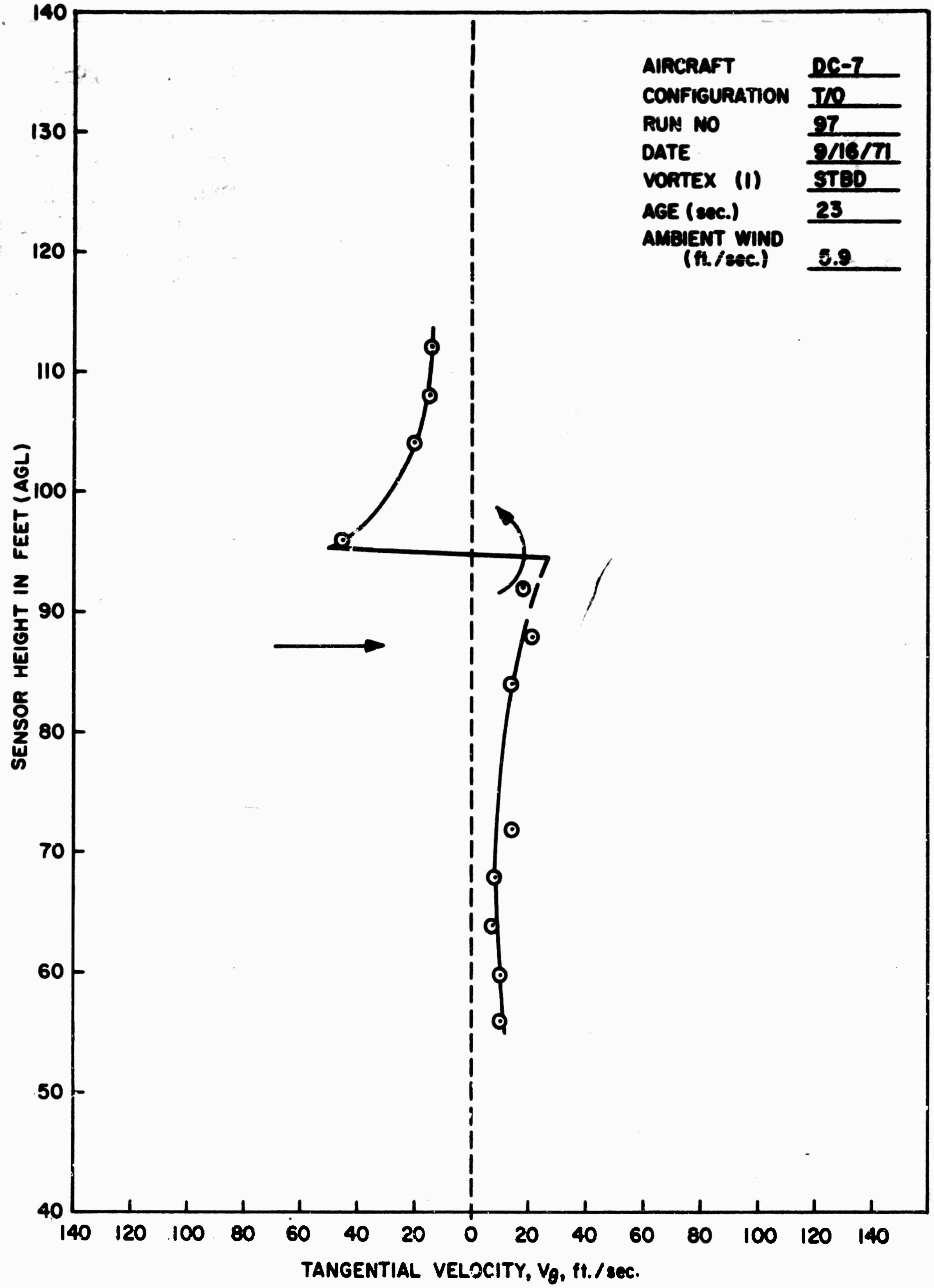
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 190
DATE 9/24/71
VORTEX (2) STBD.
AGE (sec.) 22
AMBIENT WIND (ft./sec.) 24
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

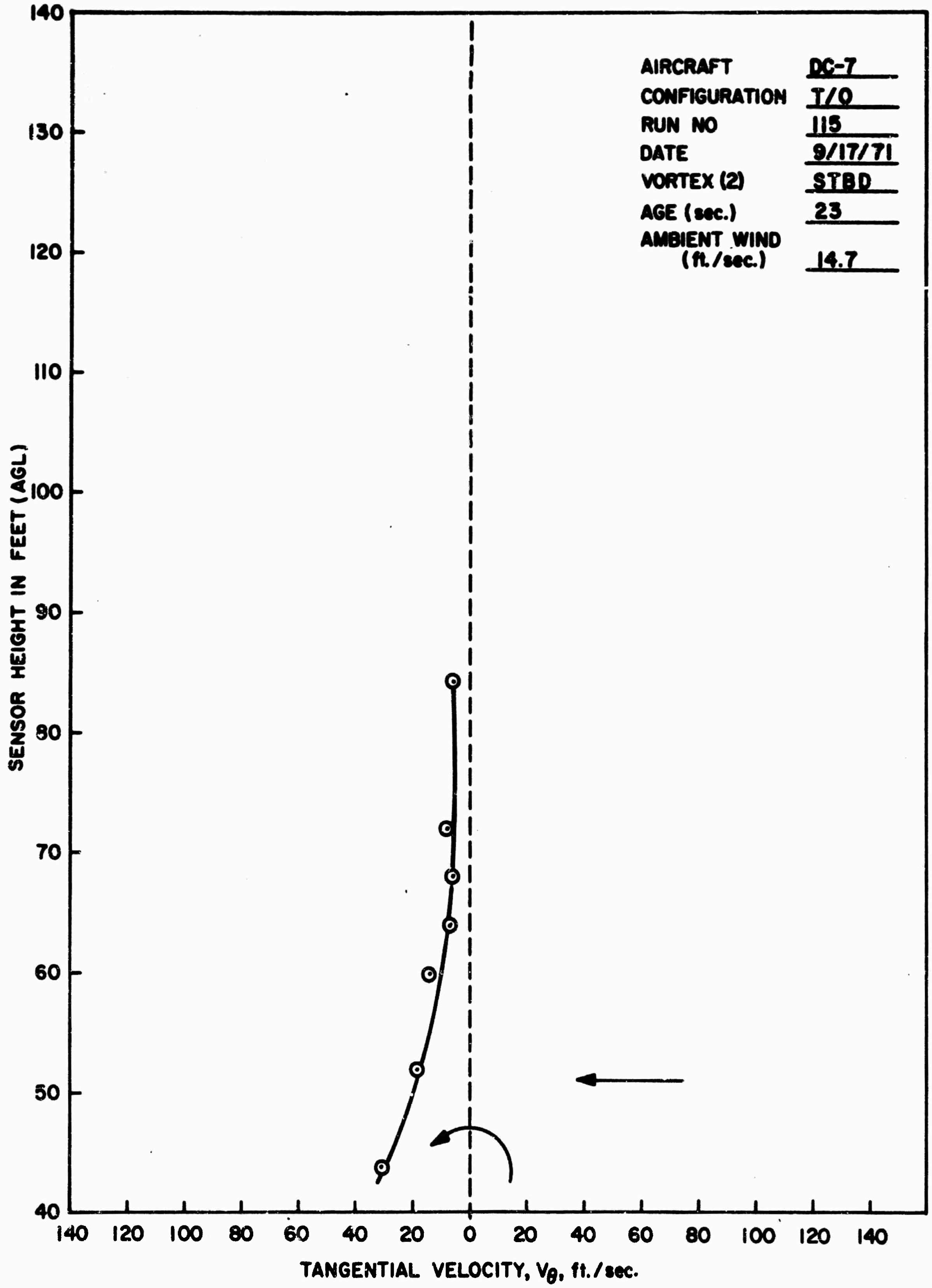


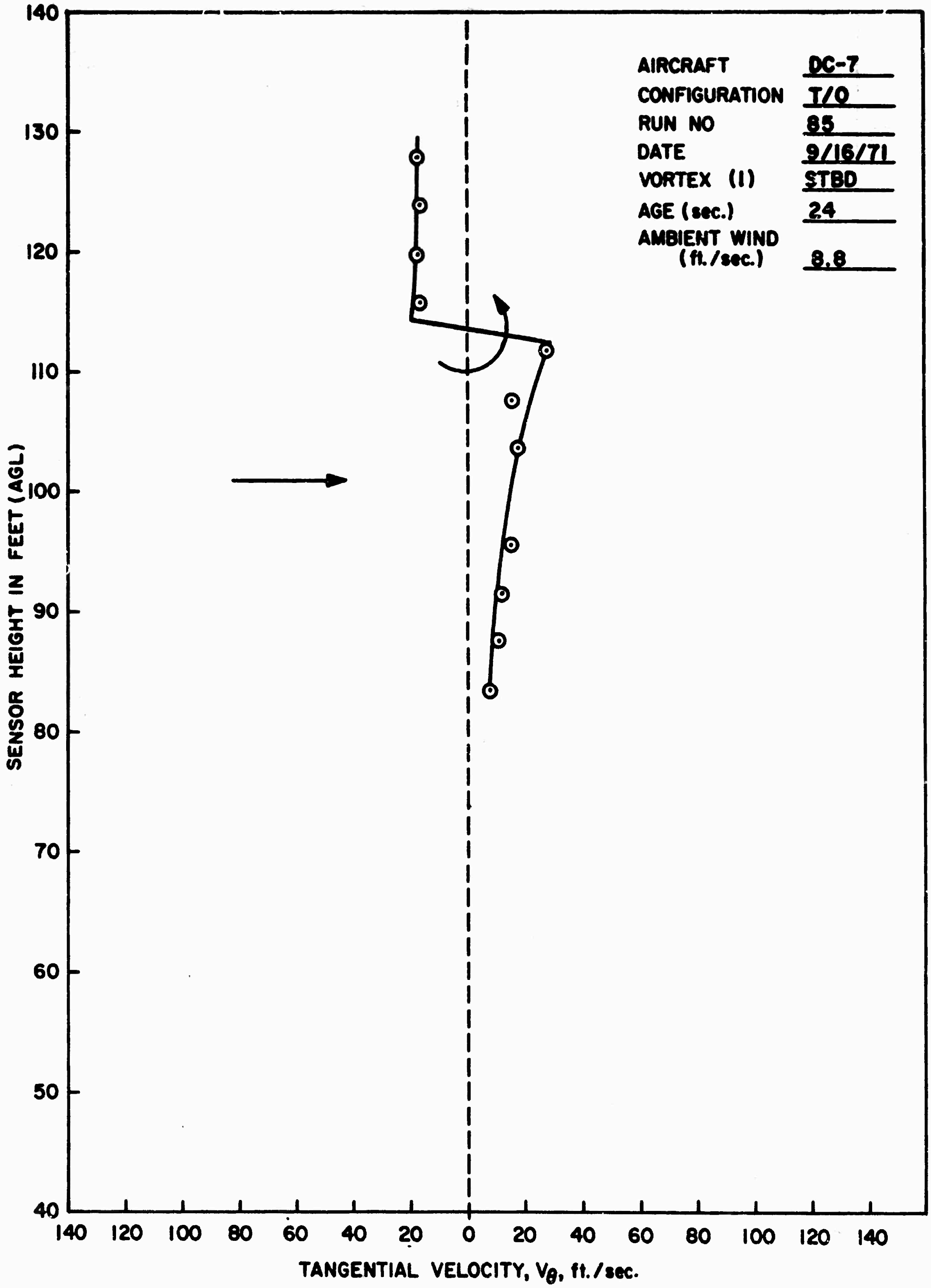
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 192
DATE 9/24/71
VORTEX (2) STBD
AGE (sec.) 22
AMBIENT WIND (ft./sec.) 22
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, Vθ, ft./sec.
100
90
80
70
60
50
40
30
20
10
0
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

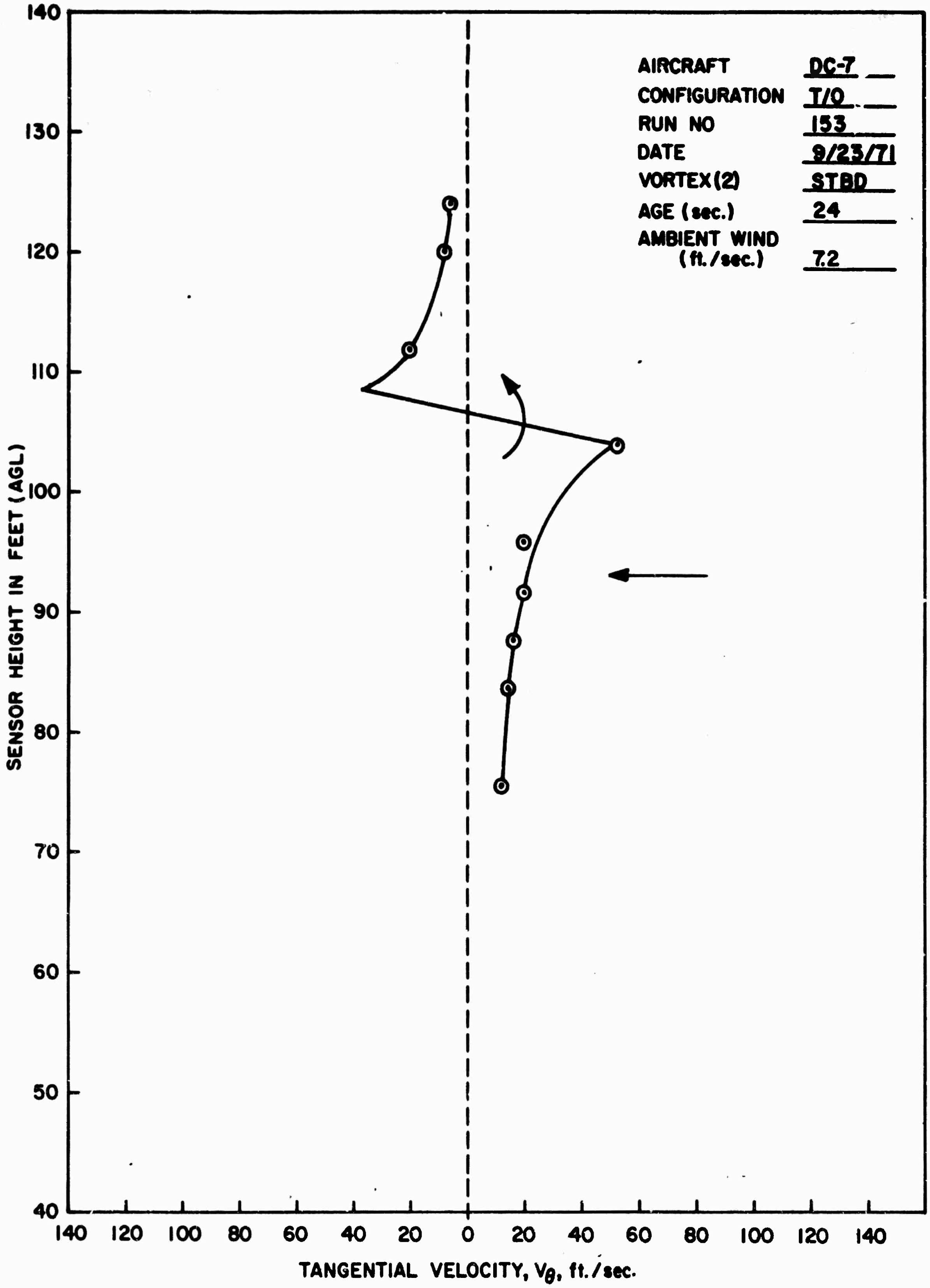

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 141
DATE 9/23/71
VORTEX(2) STBD
AGE (sec.) 22.5
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION T/O
RUN. NO 176
DATE 9/24/71
VORTEX (2) PORT
AGE (sec.) 22.5
AMBIENT WIND (ft./sec.) 17
SENSOR HEIGHT IN FEET (AGL)
100
90
80
70
60
50
40
30
20
10
0
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

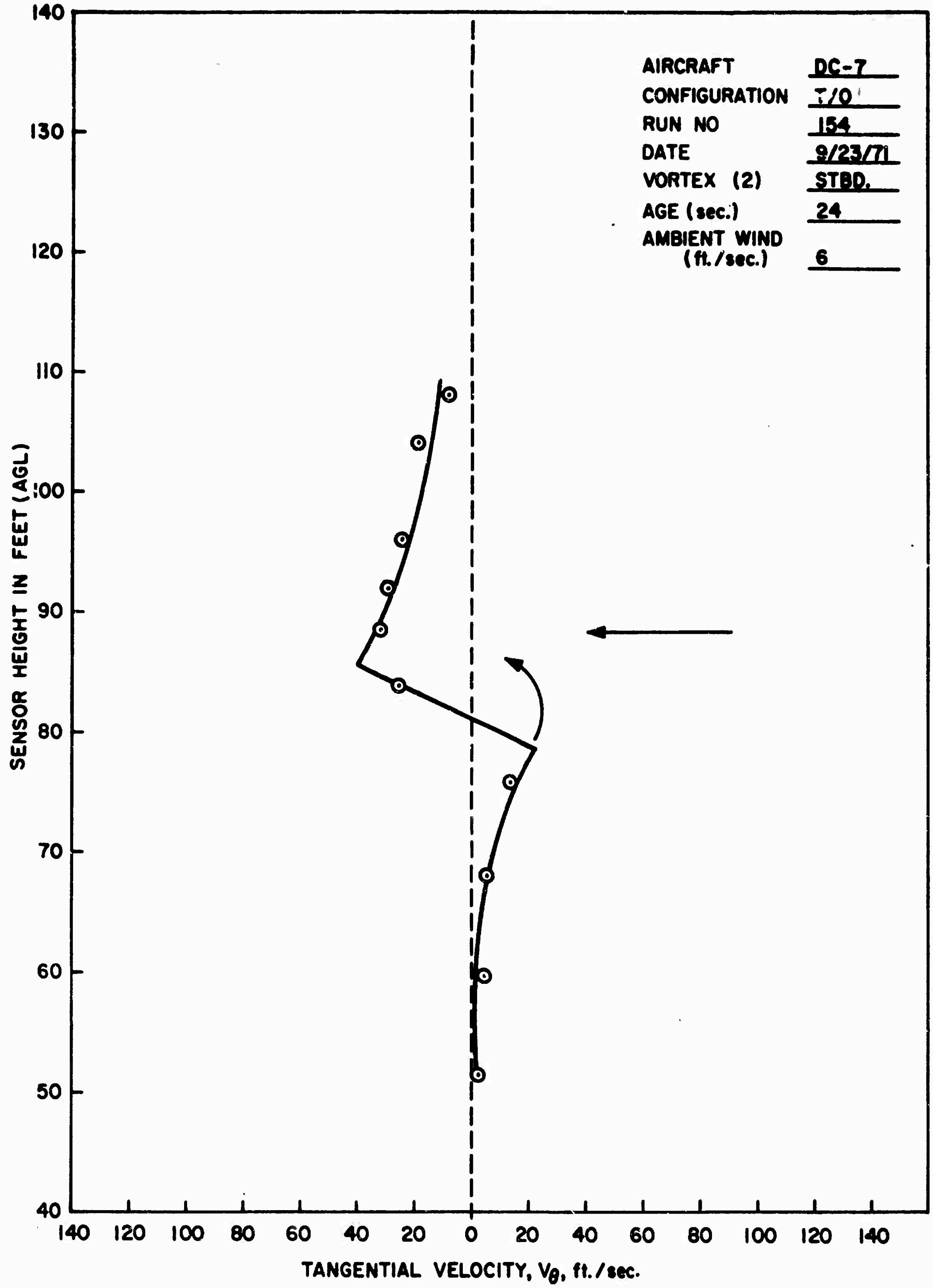

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 97
DATE 9/16/71
VORTEX (1) STBD
AGE (sec.) 23
AMBIENT WIND (ft./sec.) 5.9
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 115
DATE 9/17/71
VORTEX (2) STBD
AGE (sec.) 23
AMBIENT WIND (ft./sec.) 14.7
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, Vθ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

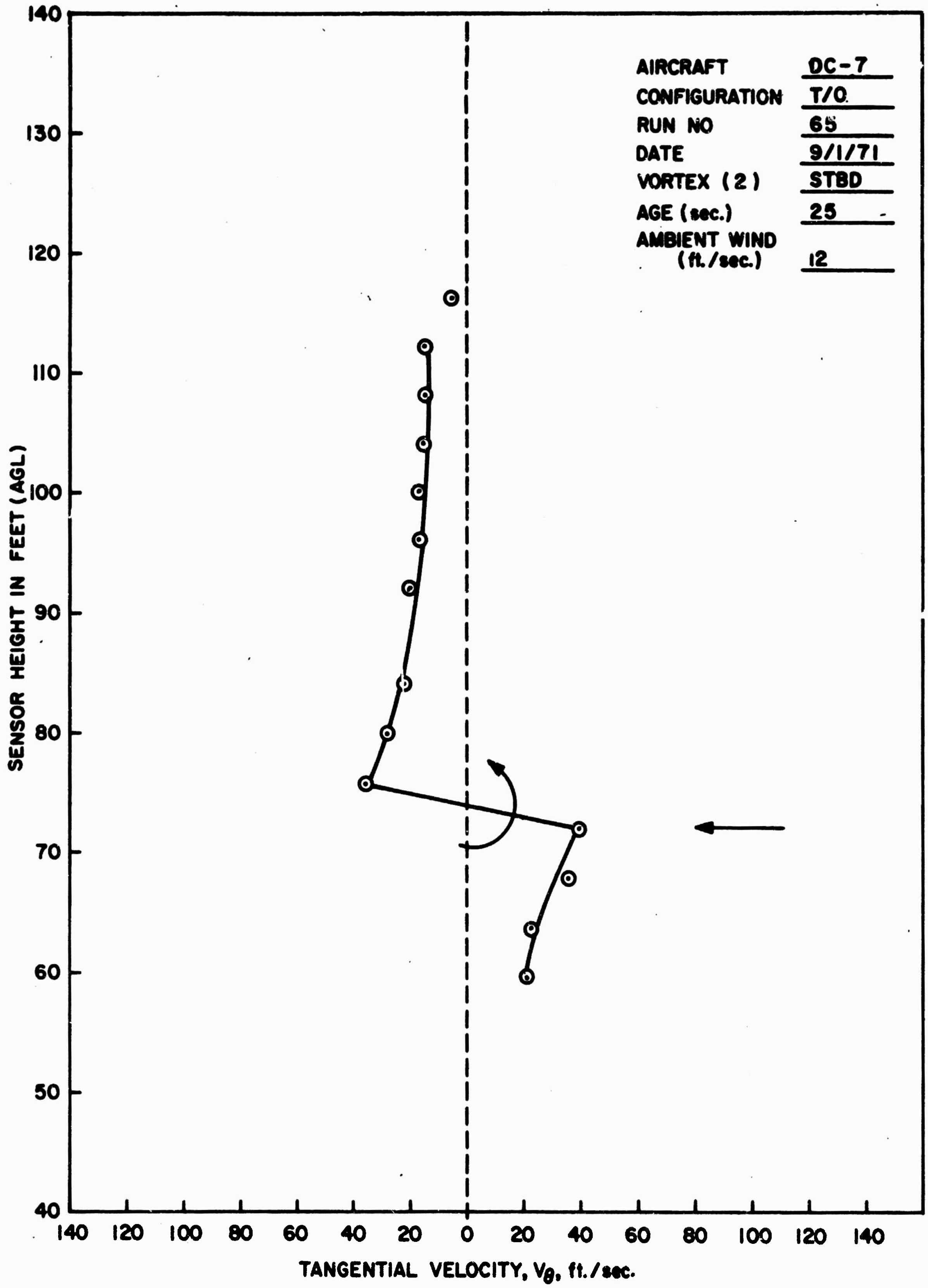

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 85
DATE 9/16/71
VORTEX (1) STBD
AGE (sec.) 24
AMBIENT WIND (ft./sec.) 8.8
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



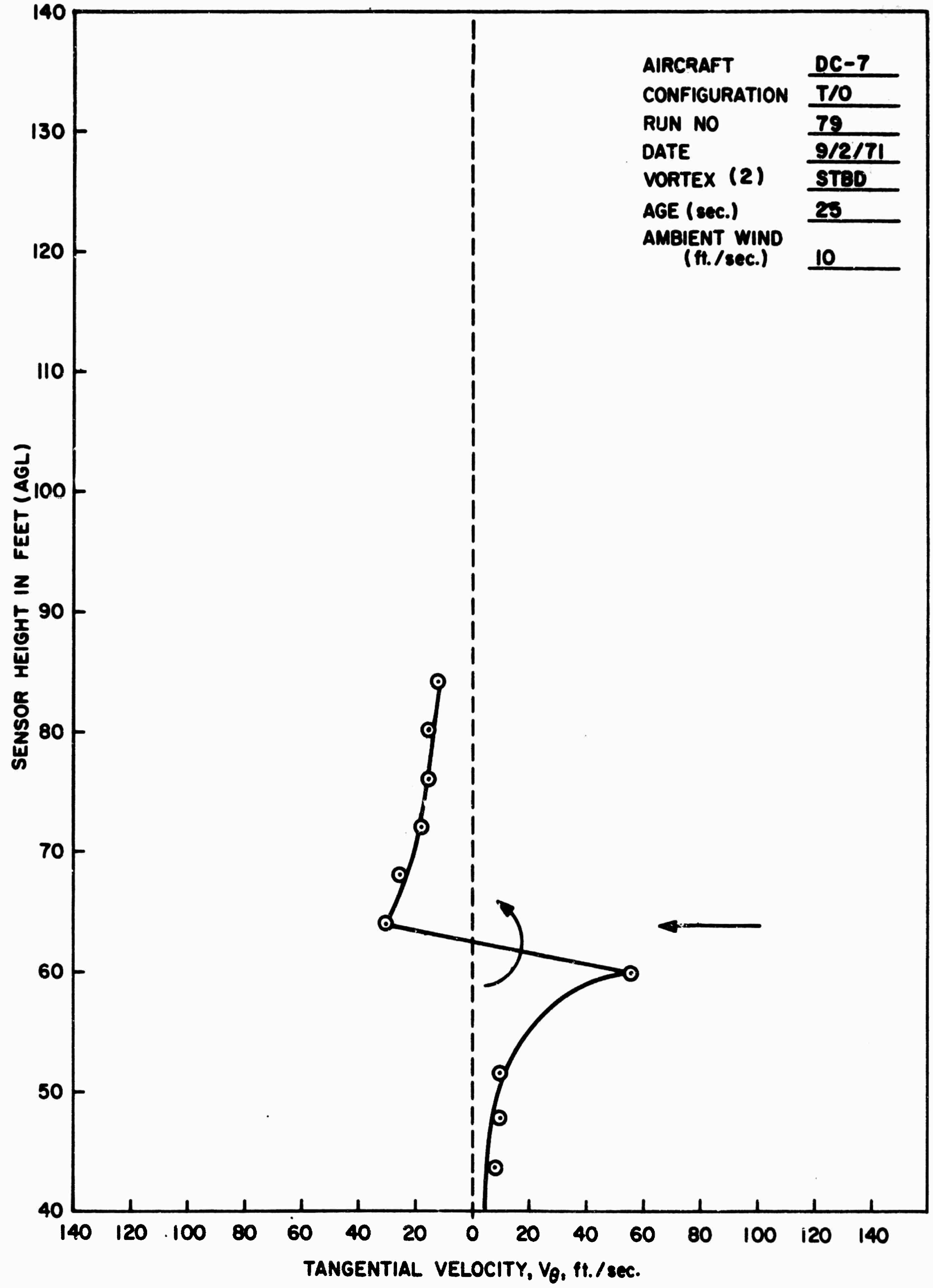
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 153
DATE 9/23/71
VORTEX(2) STBD
AGE (sec.) 24
AMBIENT WIND (ft./sec.) 7.2
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

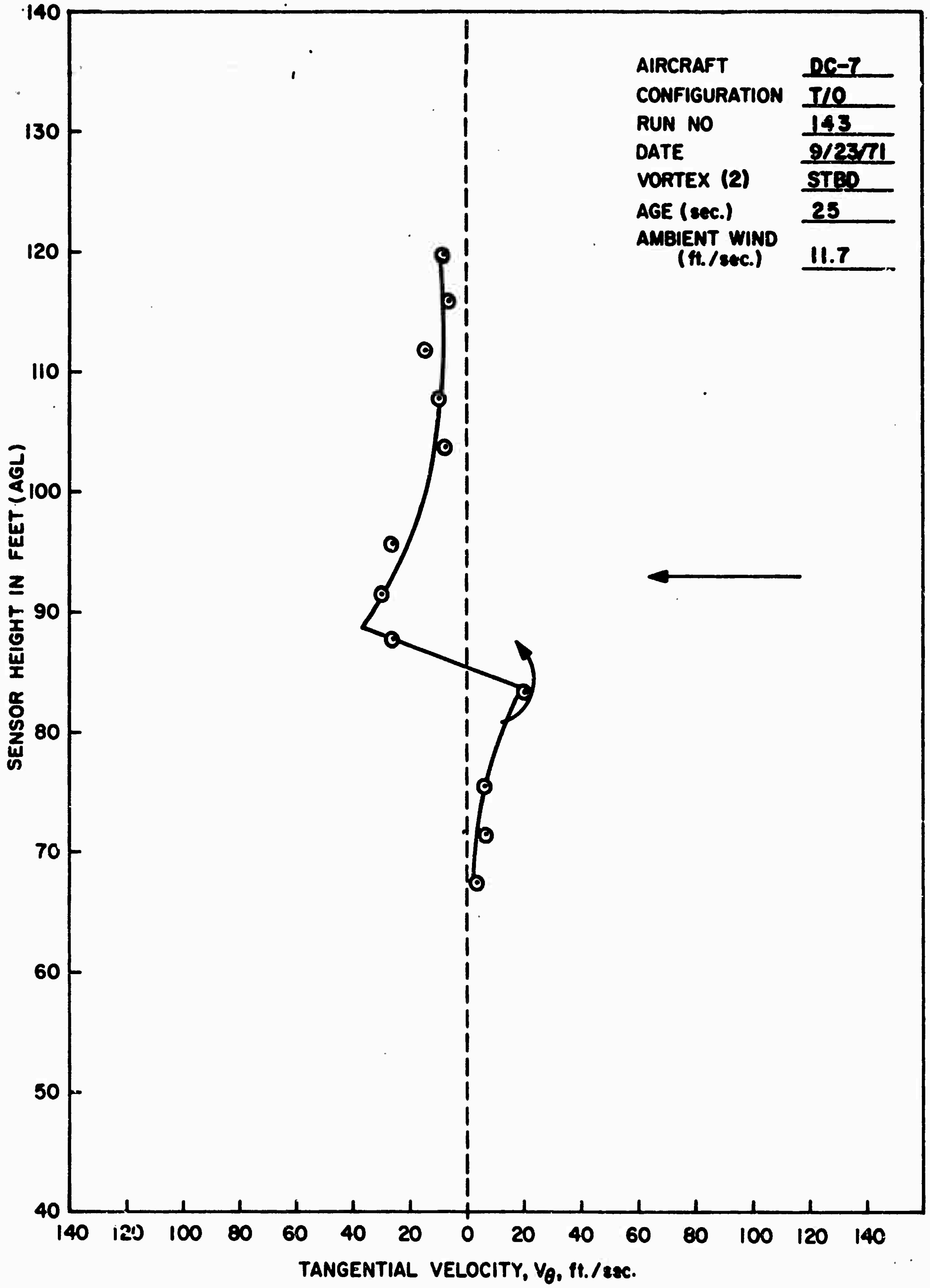


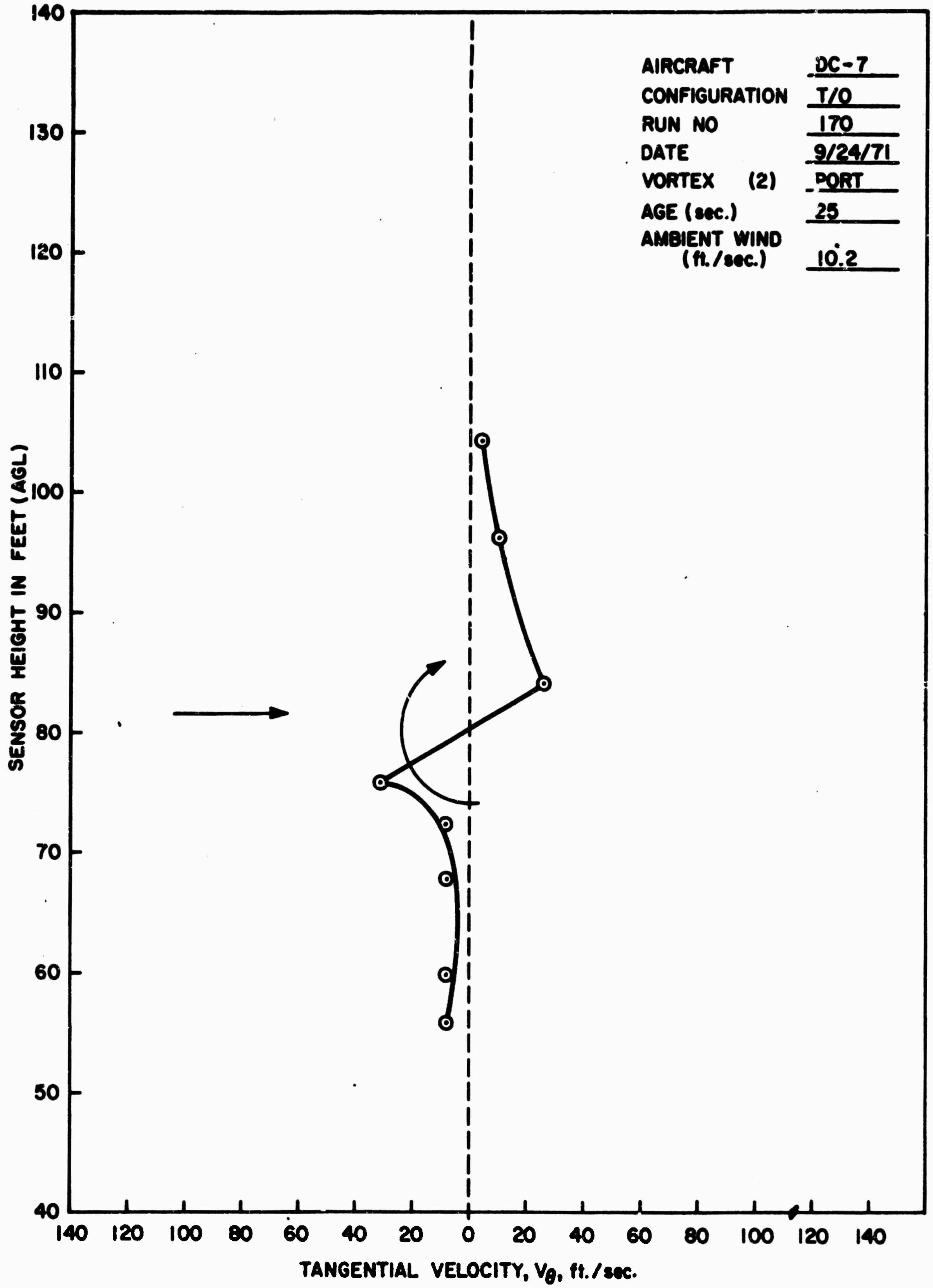
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 154
DATE 9/23/71
VORTEX (2) STBD.
AGE (sec.) 24
AMBIENT WIND (ft./sec.) 6
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

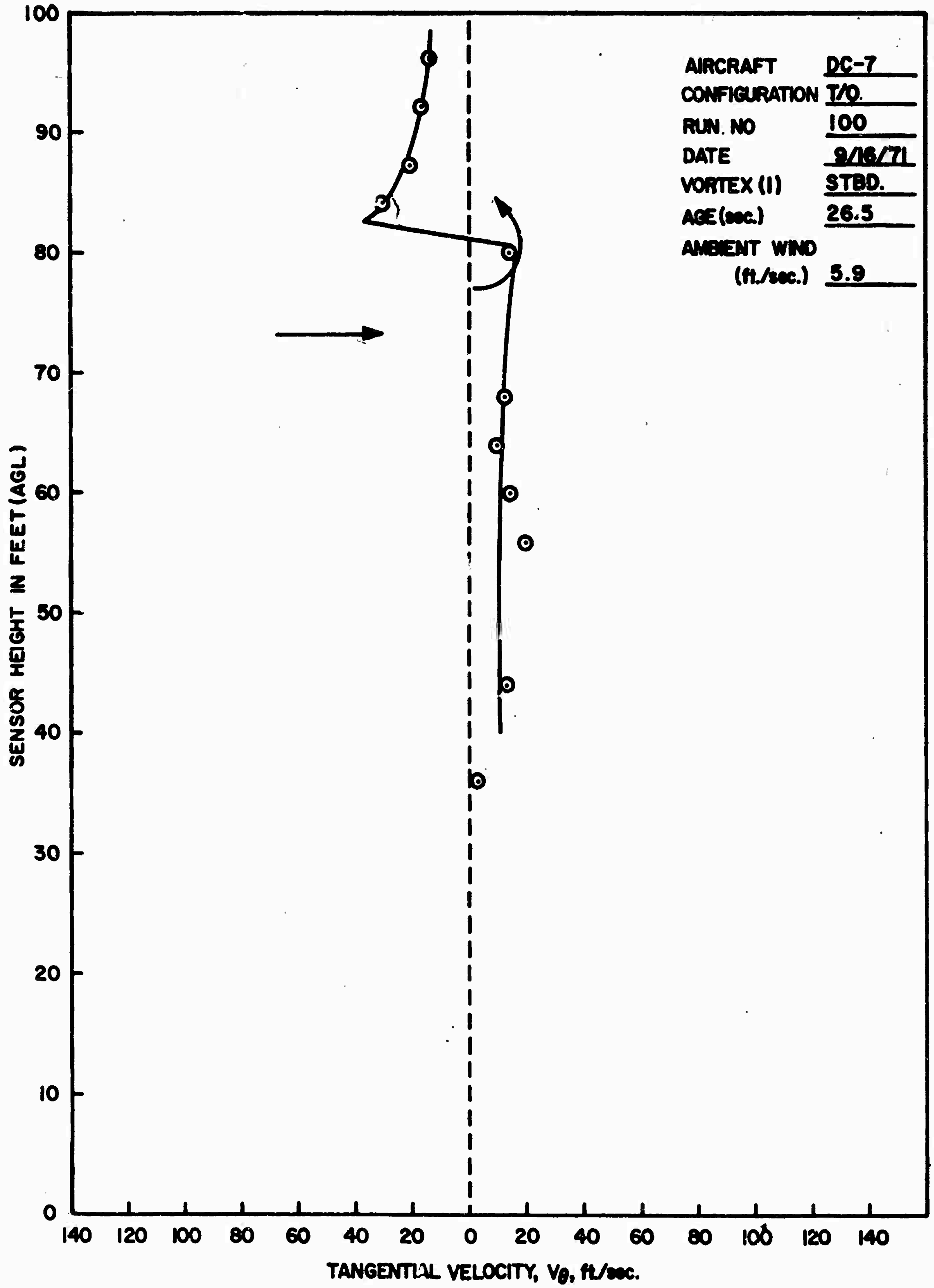


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 65
DATE 9/1/71
VORTEX (2) STBD
AGE (sec.) 25
AMBIENT WIND (ft./sec.) 12
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, Vθ, ft./sec.

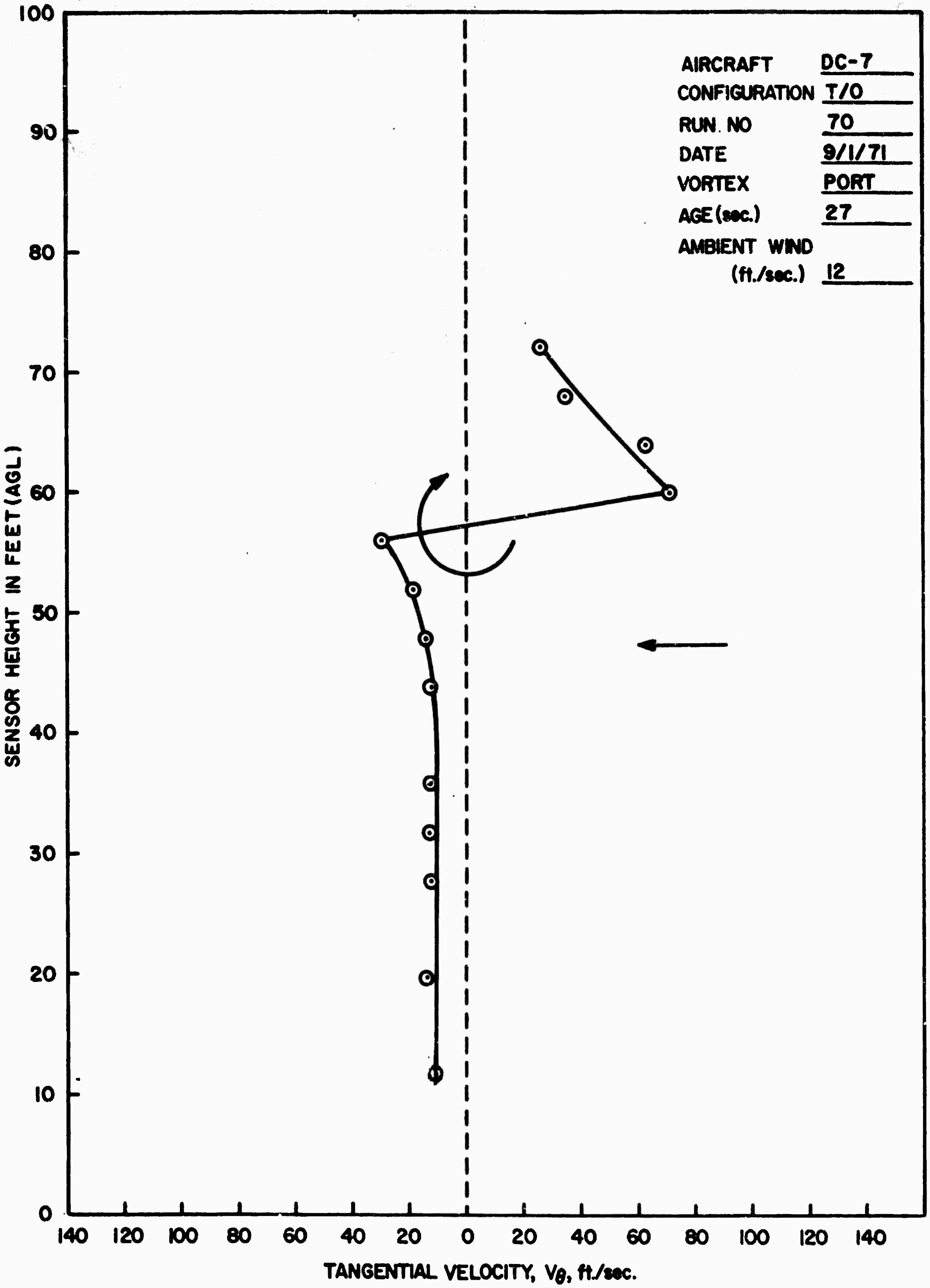

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 79
DATE 9/2/71
VORTEX (2) STBD
AGE (sec.) 25
AMBIENT WIND (ft./sec.) 10
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 143
DATE 9/23/71
VORTEX (2) STBD
AGE (sec.) 25
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

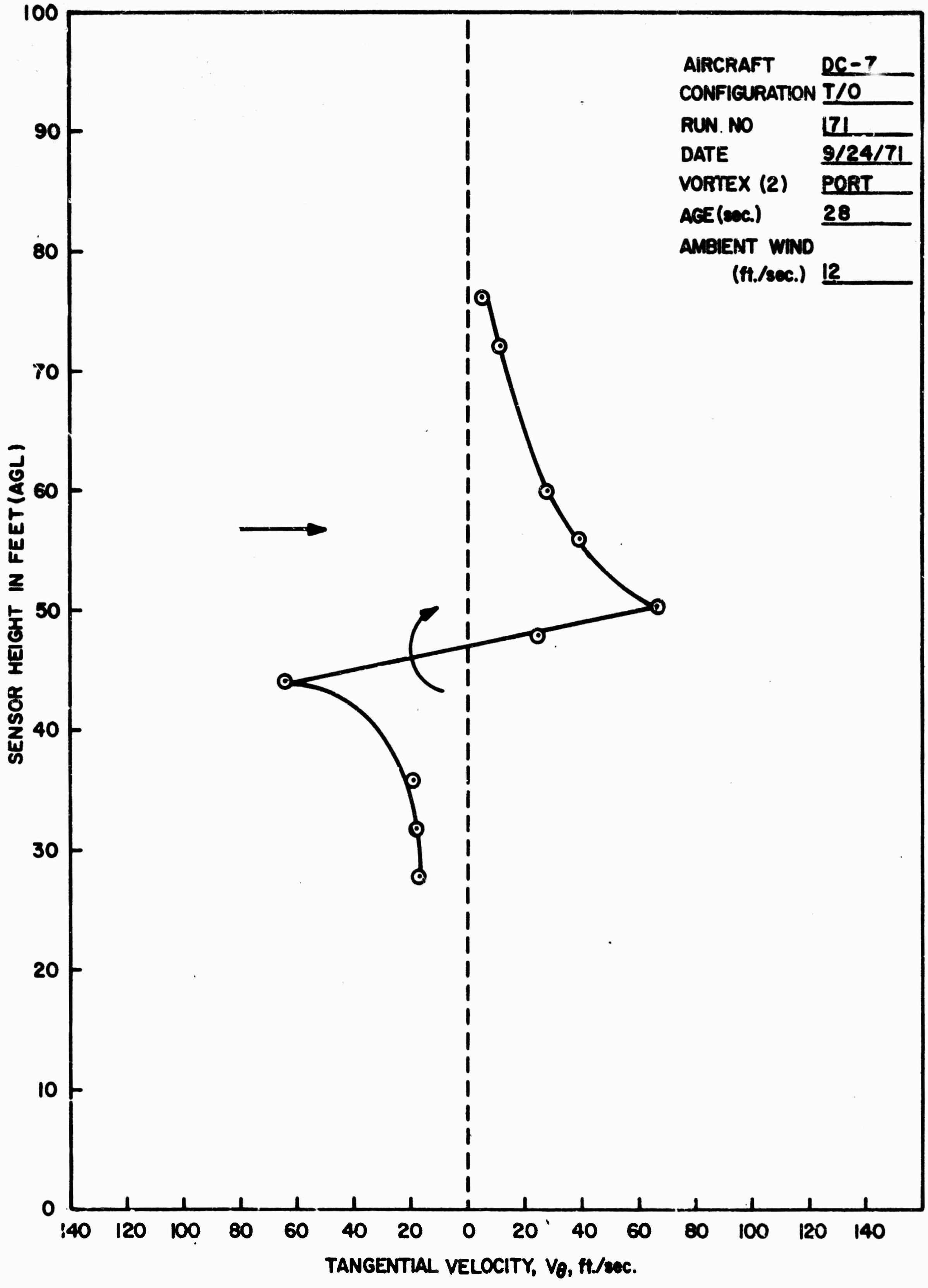

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 170
DATE 9/24/71
VORTEX (2) PORT
AGE (sec.) 25
AMBIENT WIND (ft./sec.) 10.2
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



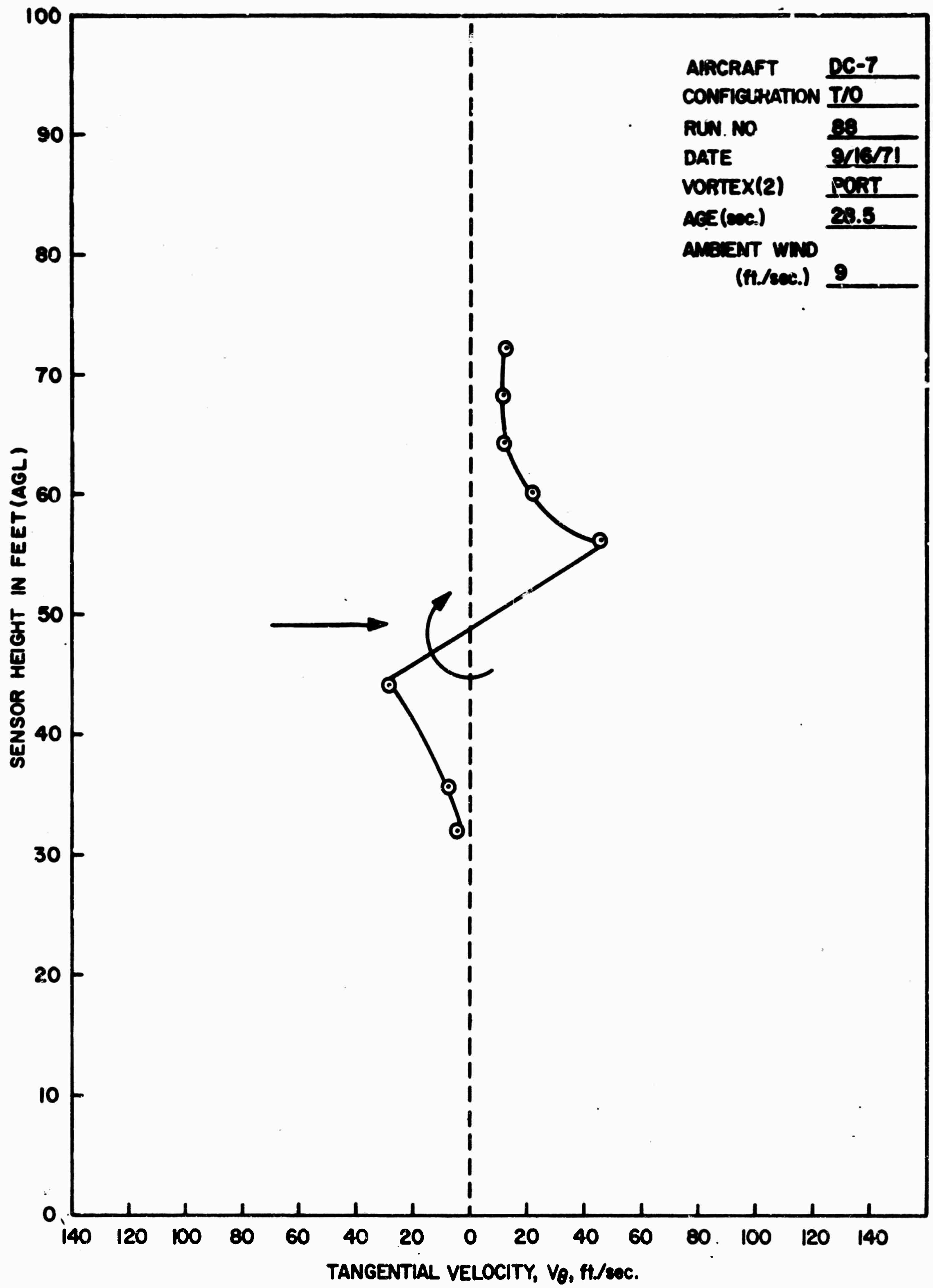
AIRCRAFT DC-7
CONFIGURATION T/O.
RUN. NO 100
DATE 9/16/71
VORTEX (1) STBD.
AGE (sec.) 26.5
AMBIENT WIND (ft./sec.) 5.9
SENSOR HEIGHT IN FEET (AGL)
100
90
80
70
60
50
40
30
20
10
0
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft/sec.



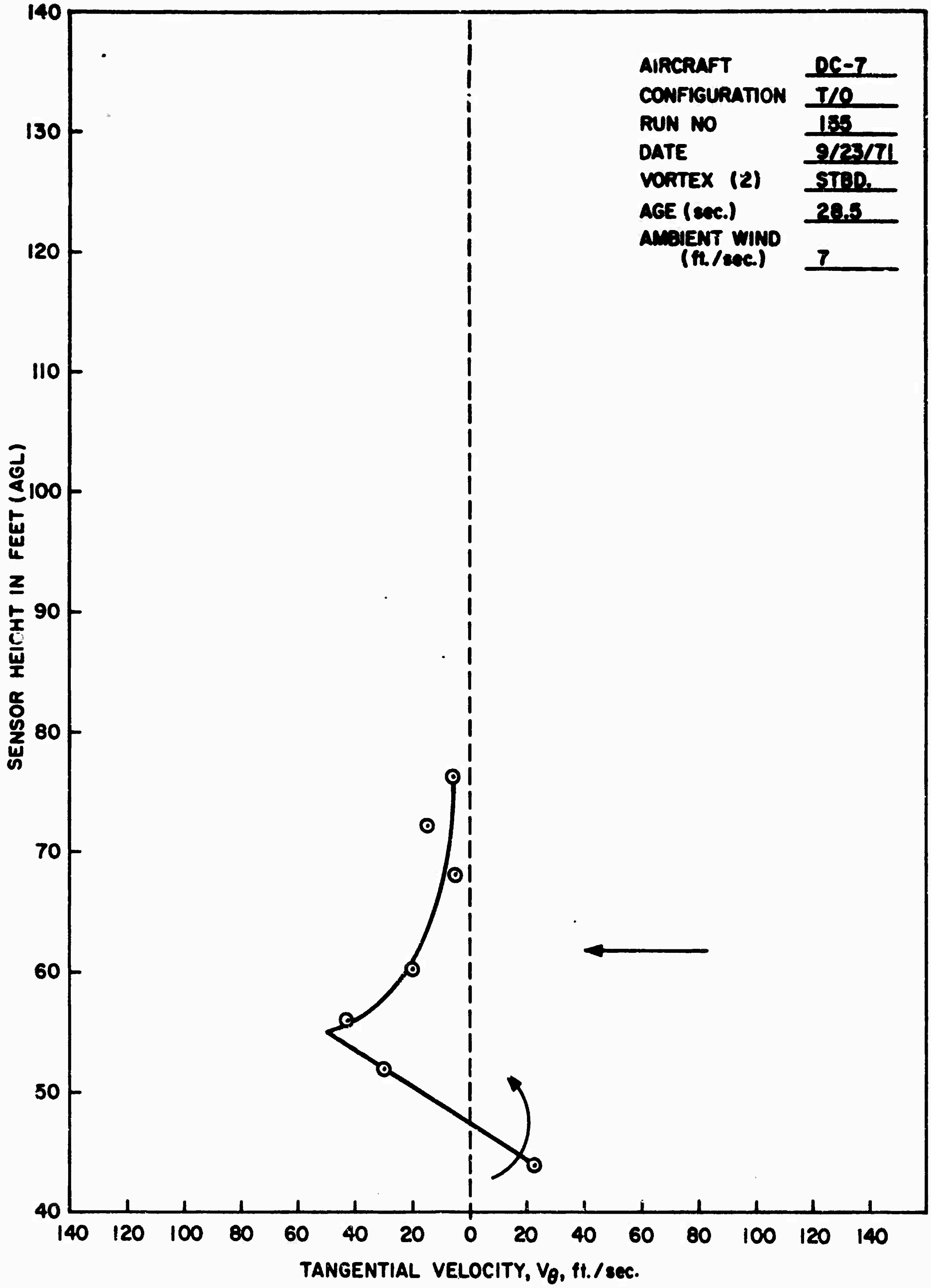
AIRCRAFT DC-7
CONFIGURATION T/O
RUN. NO 70
DATE 9/1/71
VORTEX PORT
AGE (sec.) 27
AMBIENT WIND (ft./sec.) 12
SENSOR HEIGHT IN FEET (AGL)
100
90
80
70
60
50
40
30
20
10
0
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

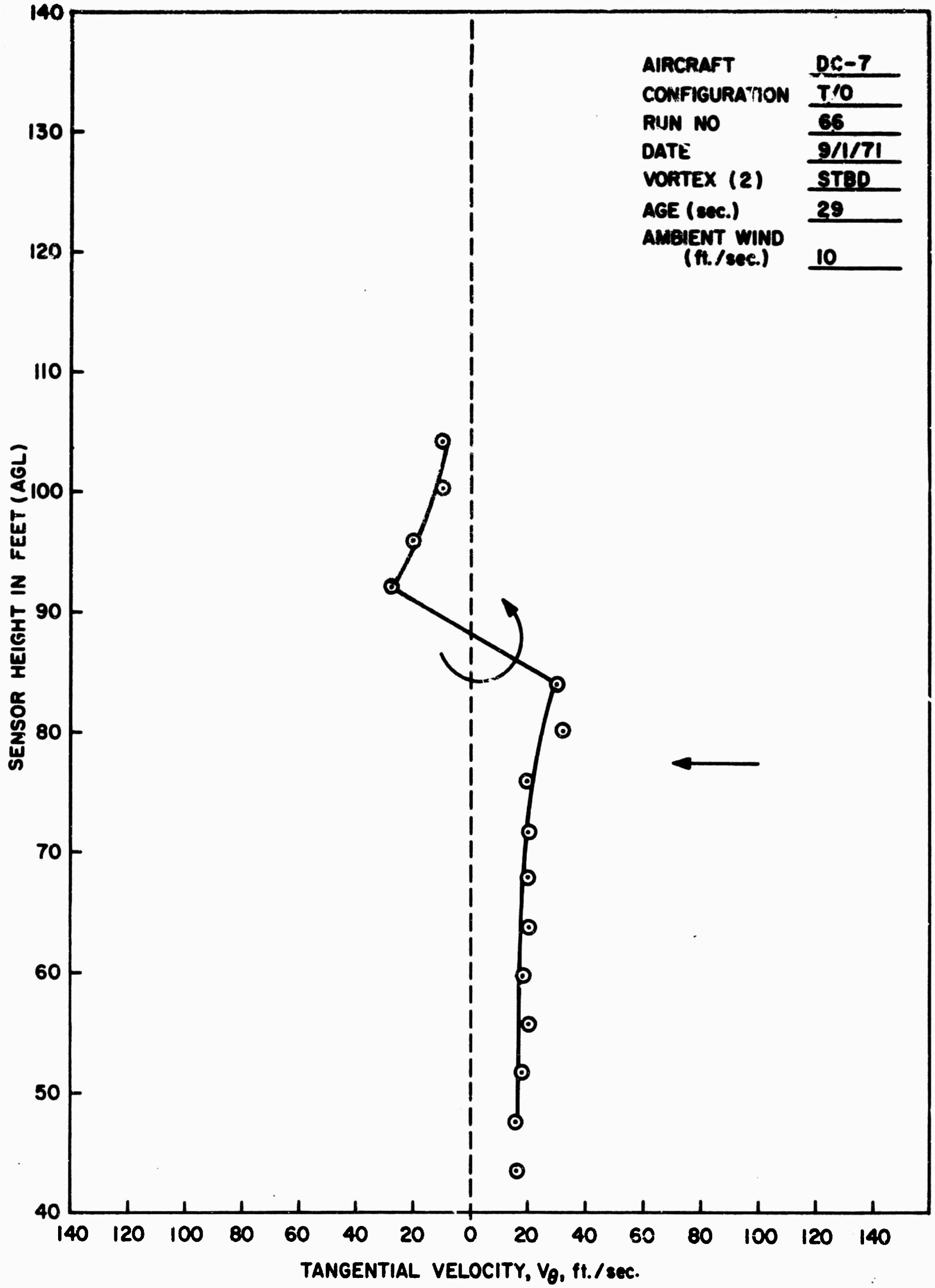


AIRCRAFT DC-7
CONFIGURATION T/O
RUN. NO 171
DATE 9/24/71
VORTEX (2) PORT
AGE (sec.) 28
AMBIENT WIND (ft./sec.) 12
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
0
10
20
30
40
50
60
70
80
90
100
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

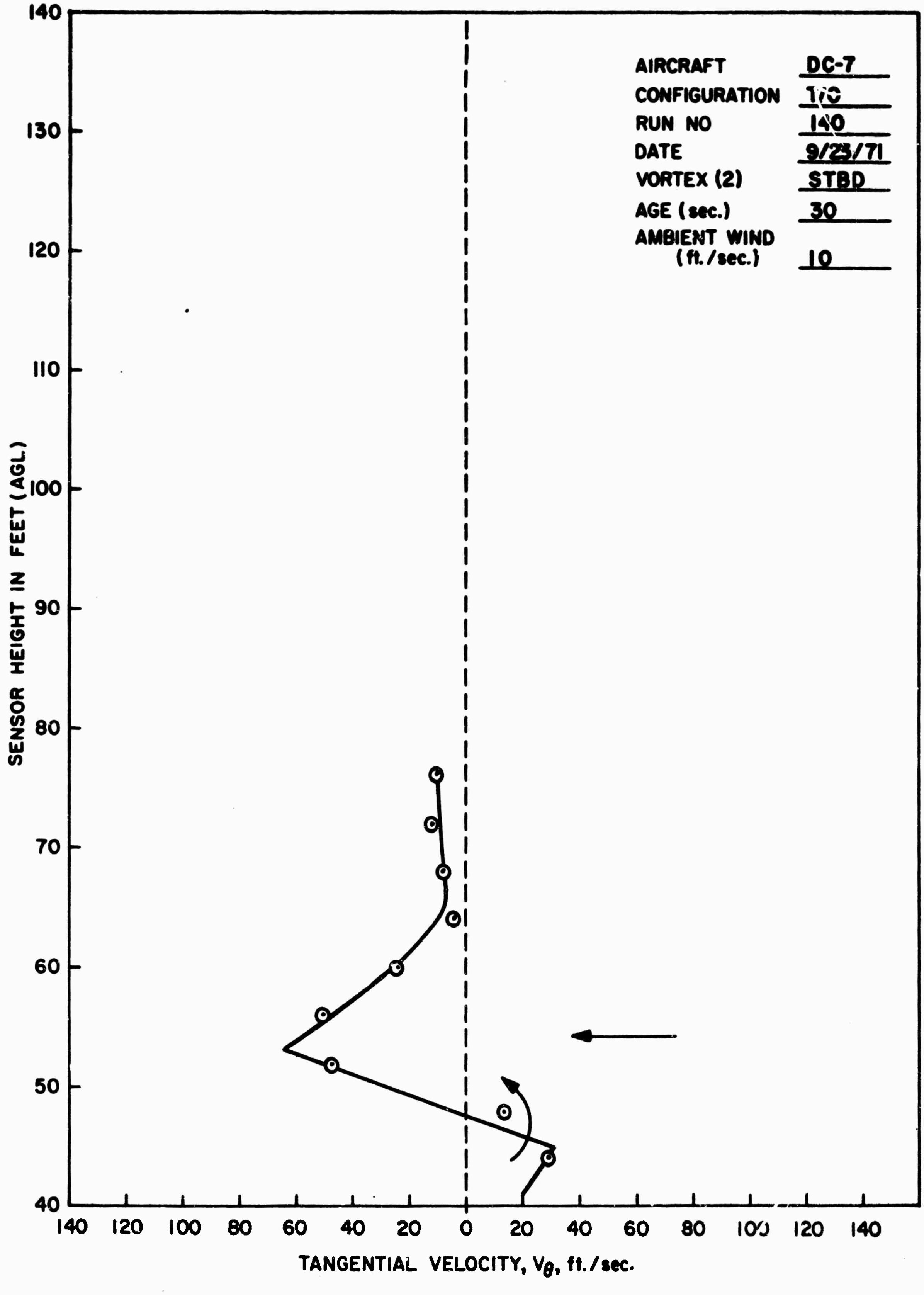


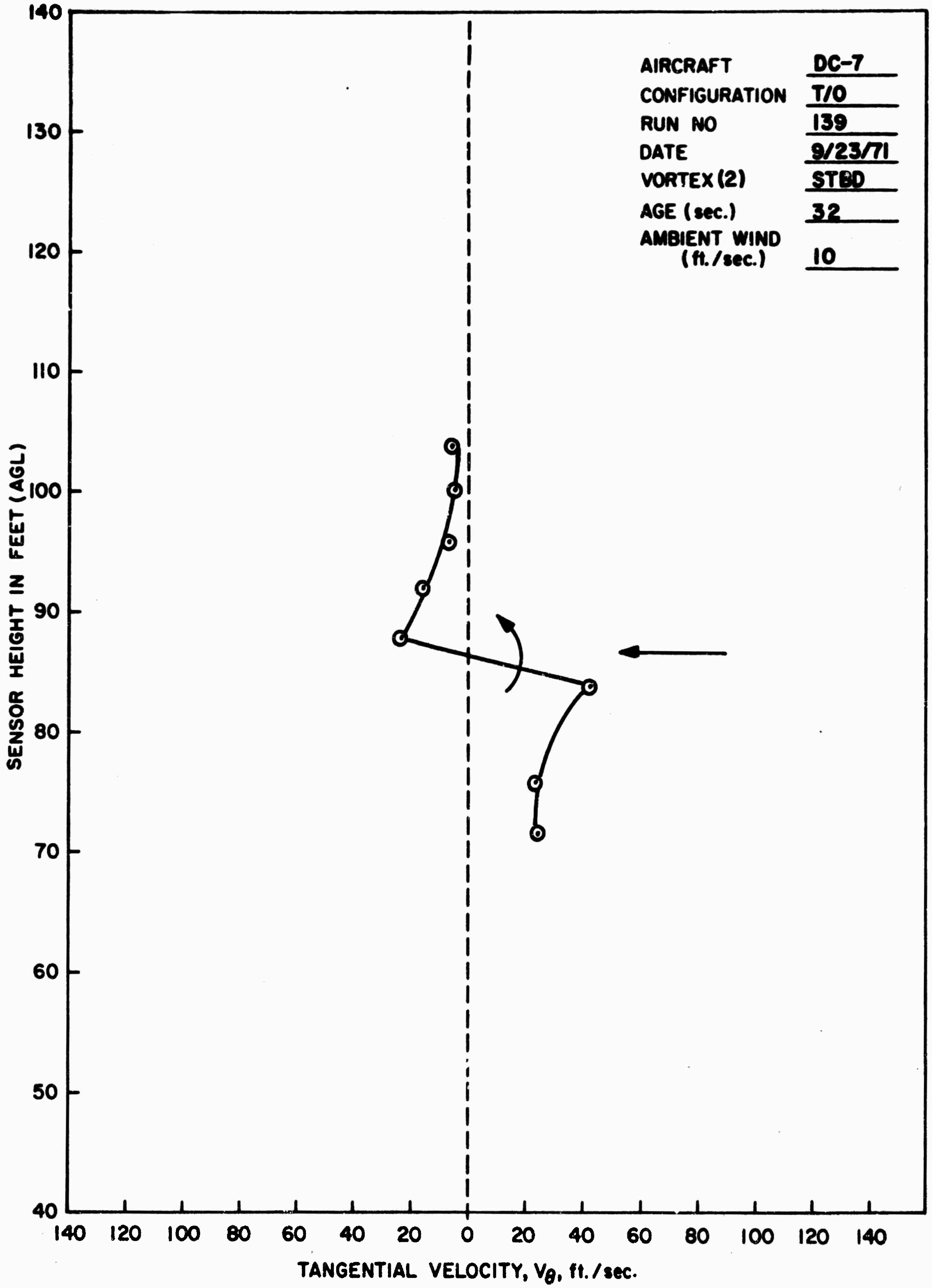
AIRCRAFT DC-7
CONFIGURATION T/O
RUN. NO 88
DATE 9/16/71
VORTEX(2) PORT
AGE (sec.) 28.5
AMBIENT WIND (ft./sec.) 9
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, Vθ, ft./sec.
100
90
80
70
60
50
40
30
20
10
0
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

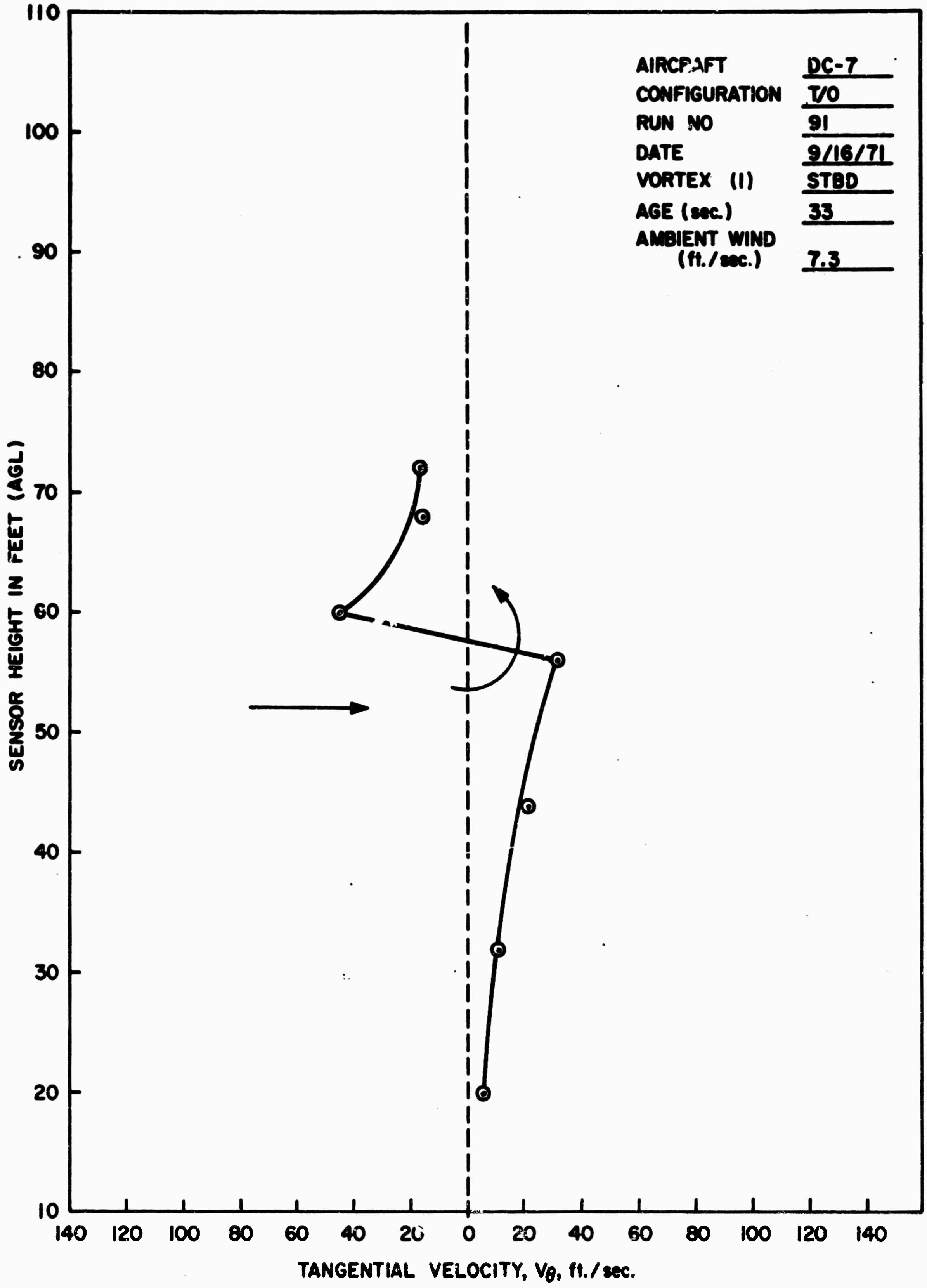

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 155
DATE 9/23/71
VORTEX (2) STBD.
AGE (sec.) 28.5
AMBIENT WIND (ft./sec.) 7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



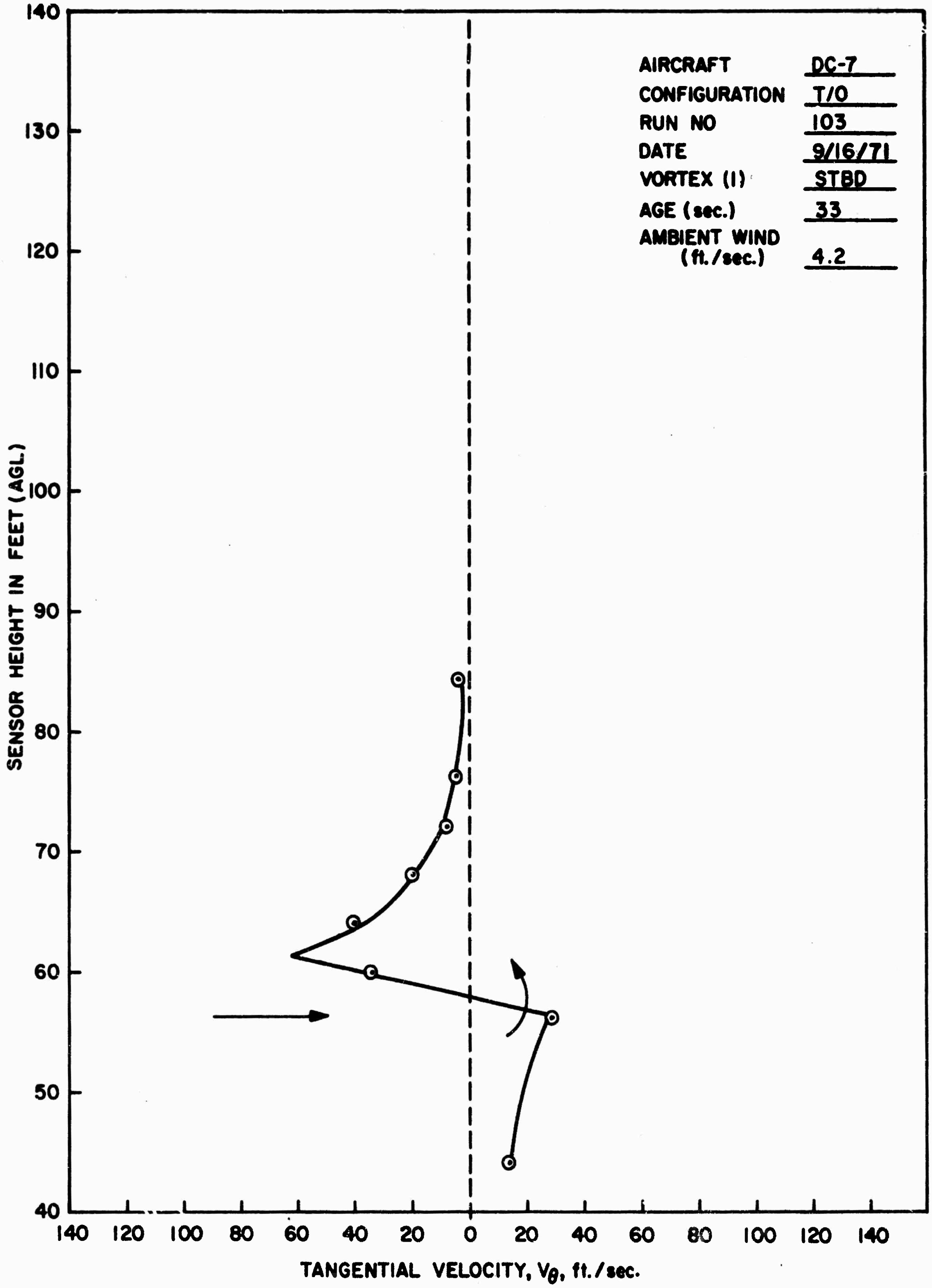
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 66
DATE 9/1/71
VORTEX (2) STBD
AGE (sec.) 29
AMBIENT WIND (ft./sec.) 10
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

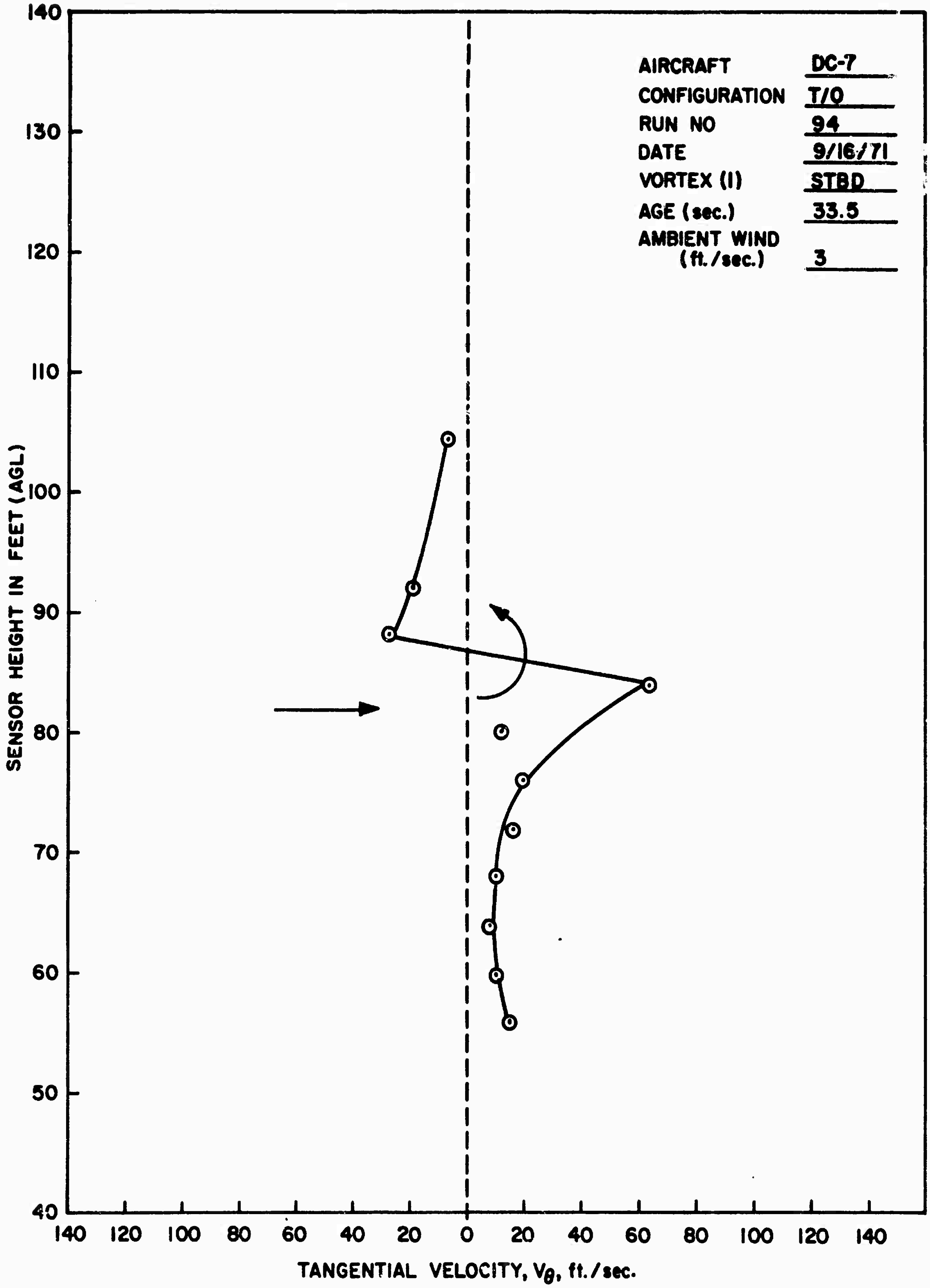

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 140
DATE 9/23/71
VORTEX (2) STBD
AGE (sec.) 30
AMBIENT WIND (ft./sec.) 10
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 139
DATE 9/23/71
VORTEX (2) STBD
AGE (sec.) 32
AMBIENT WIND (ft./sec.) 10
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, Vθ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

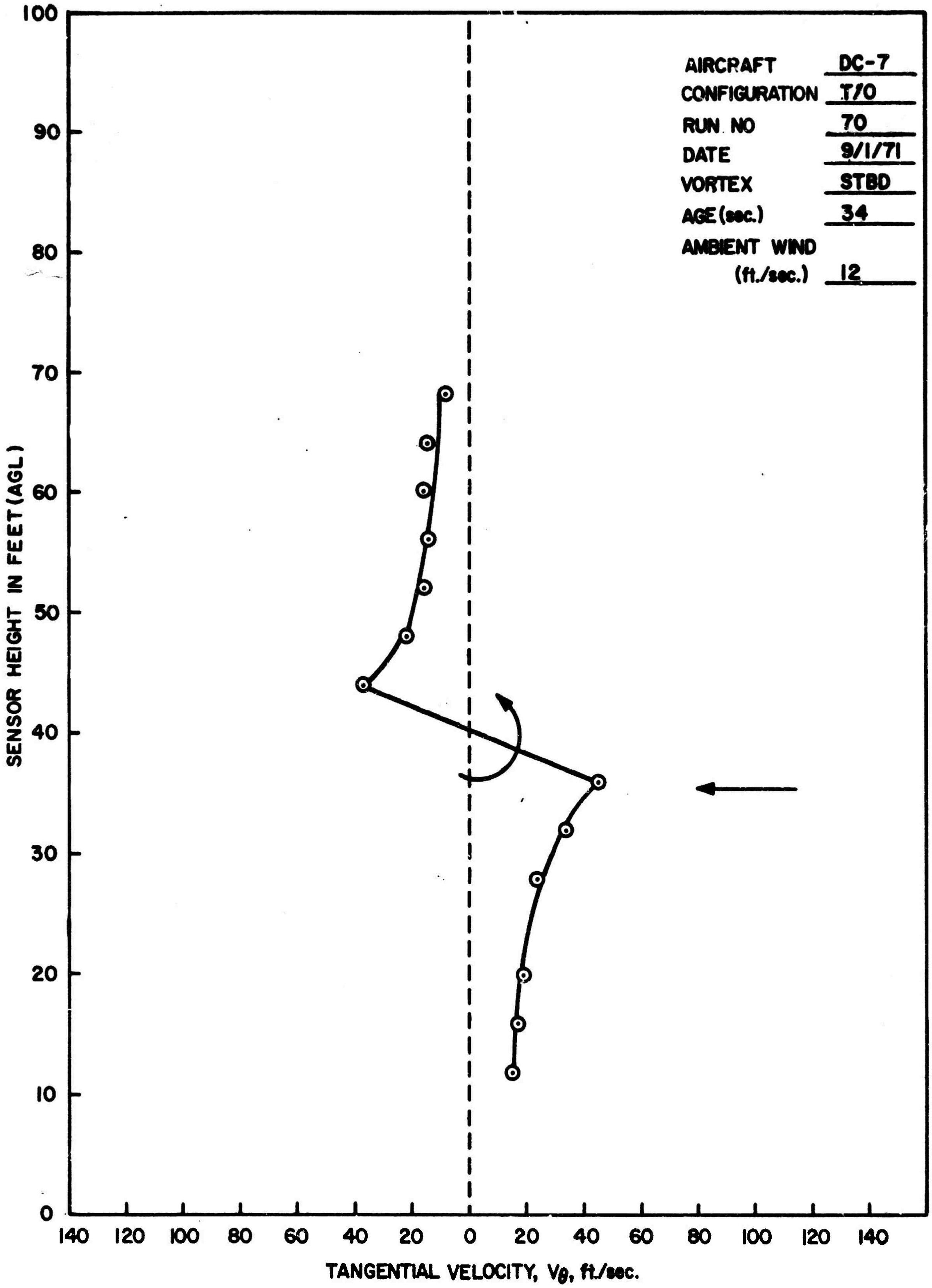


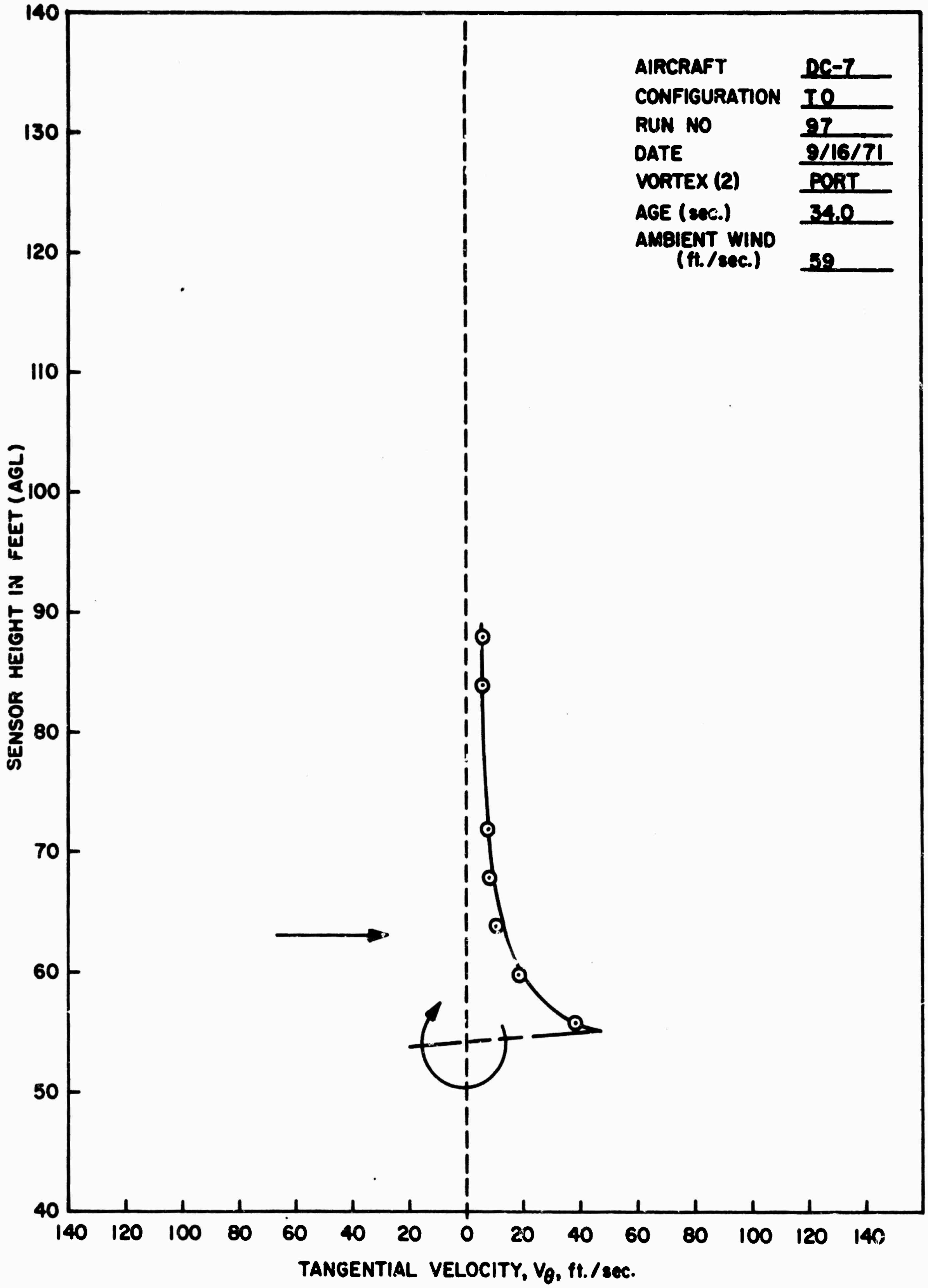
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 91
DATE 9/16/71
VORTEX (1) STBD
AGE (sec.) 33
AMBIENT WIND (ft./sec.) 7.3
SENSOR HEIGHT IN FEET (AGL)
110
100
90
80
70
60
50
40
30
20
10
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

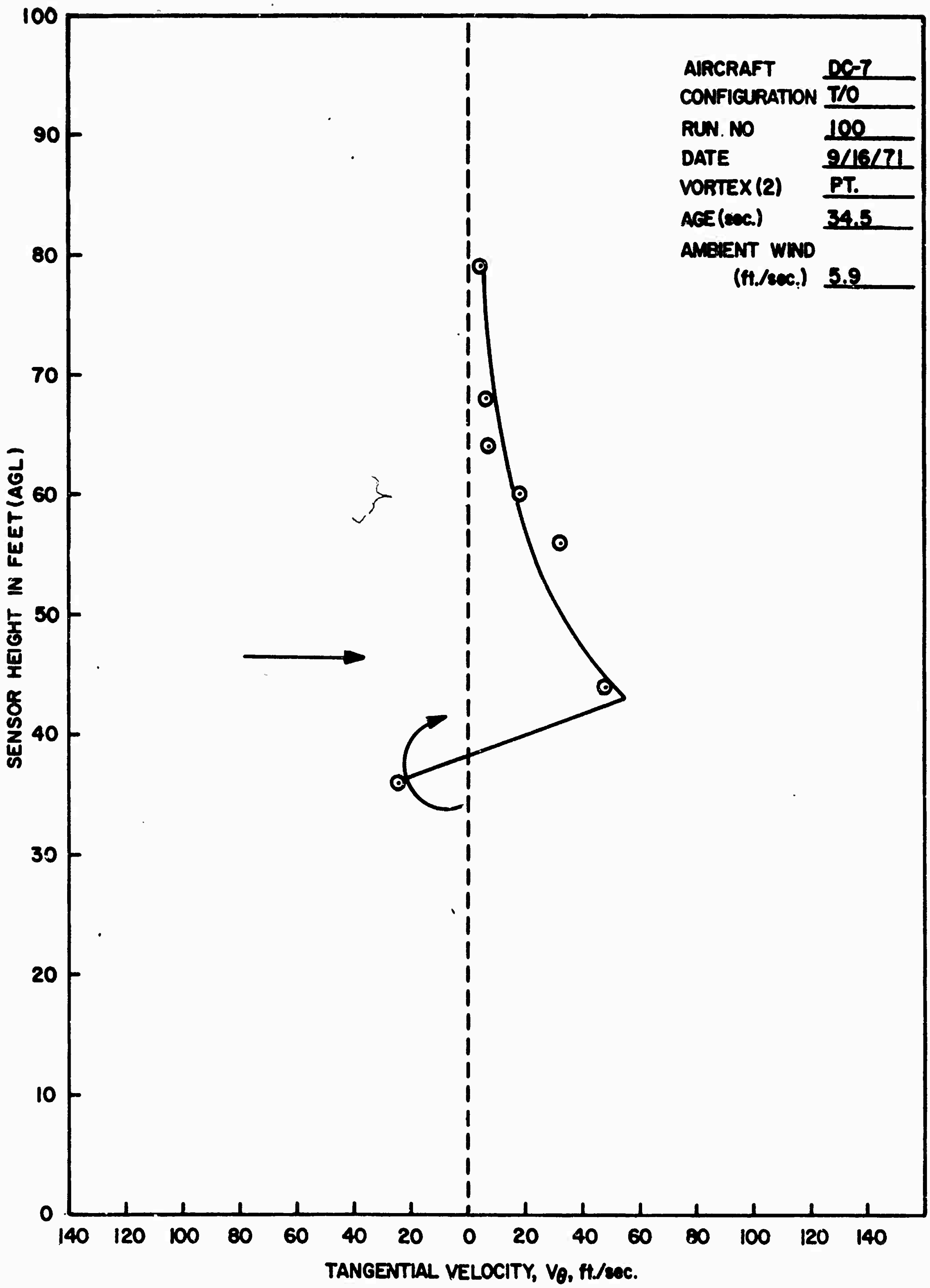

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 103
DATE 9/16/71
VORTEX (1) STBD
AGE (sec.) 33
AMBIENT WIND (ft./sec.) 4.2
SENSOR HEIGHT IN FEET (AGL.)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



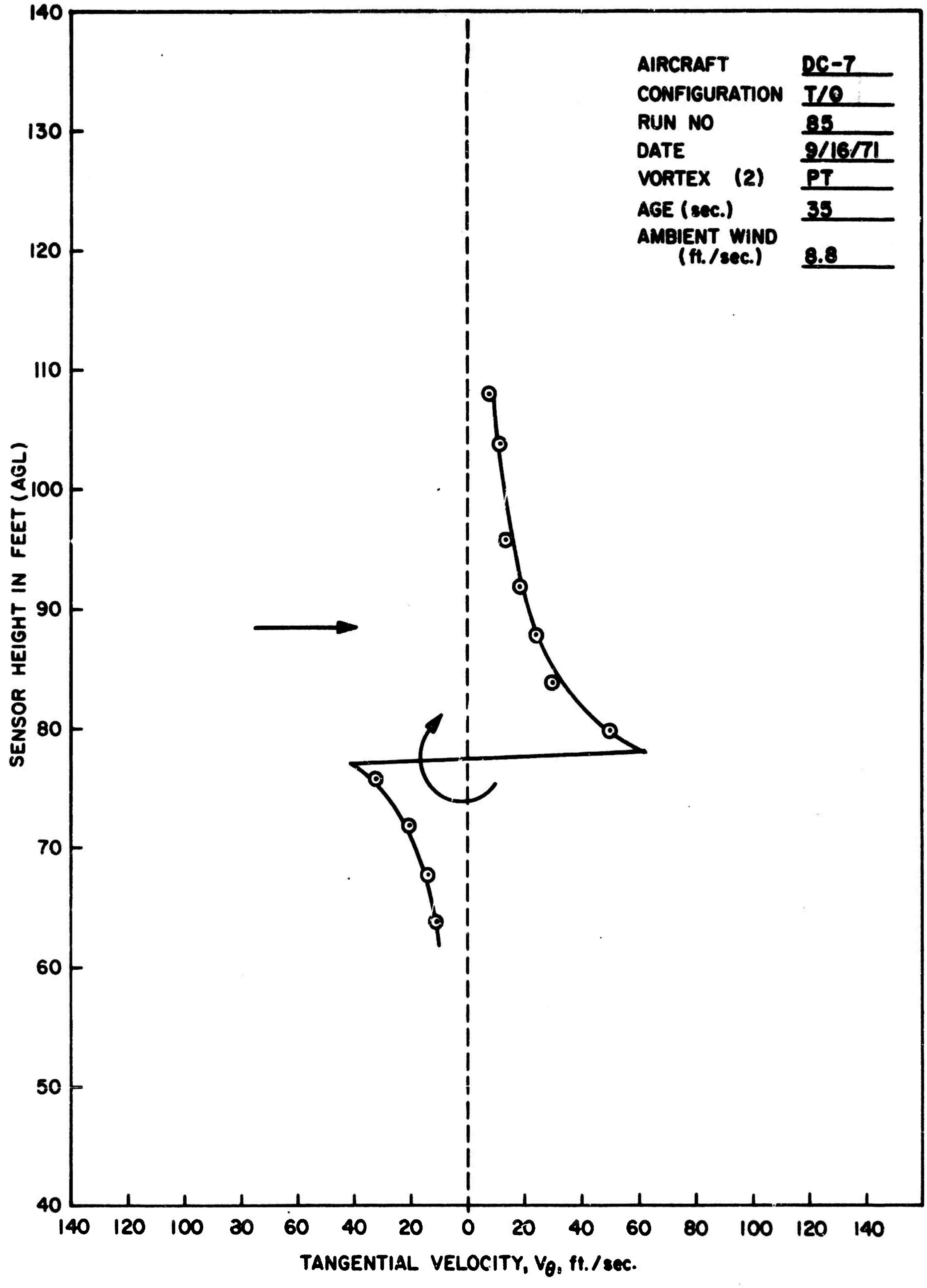
AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 94
DATE 9/16/71
VORTEX (1) STBD
AGE (sec.) 33.5
AMBIENT WIND (ft./sec.) 3
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

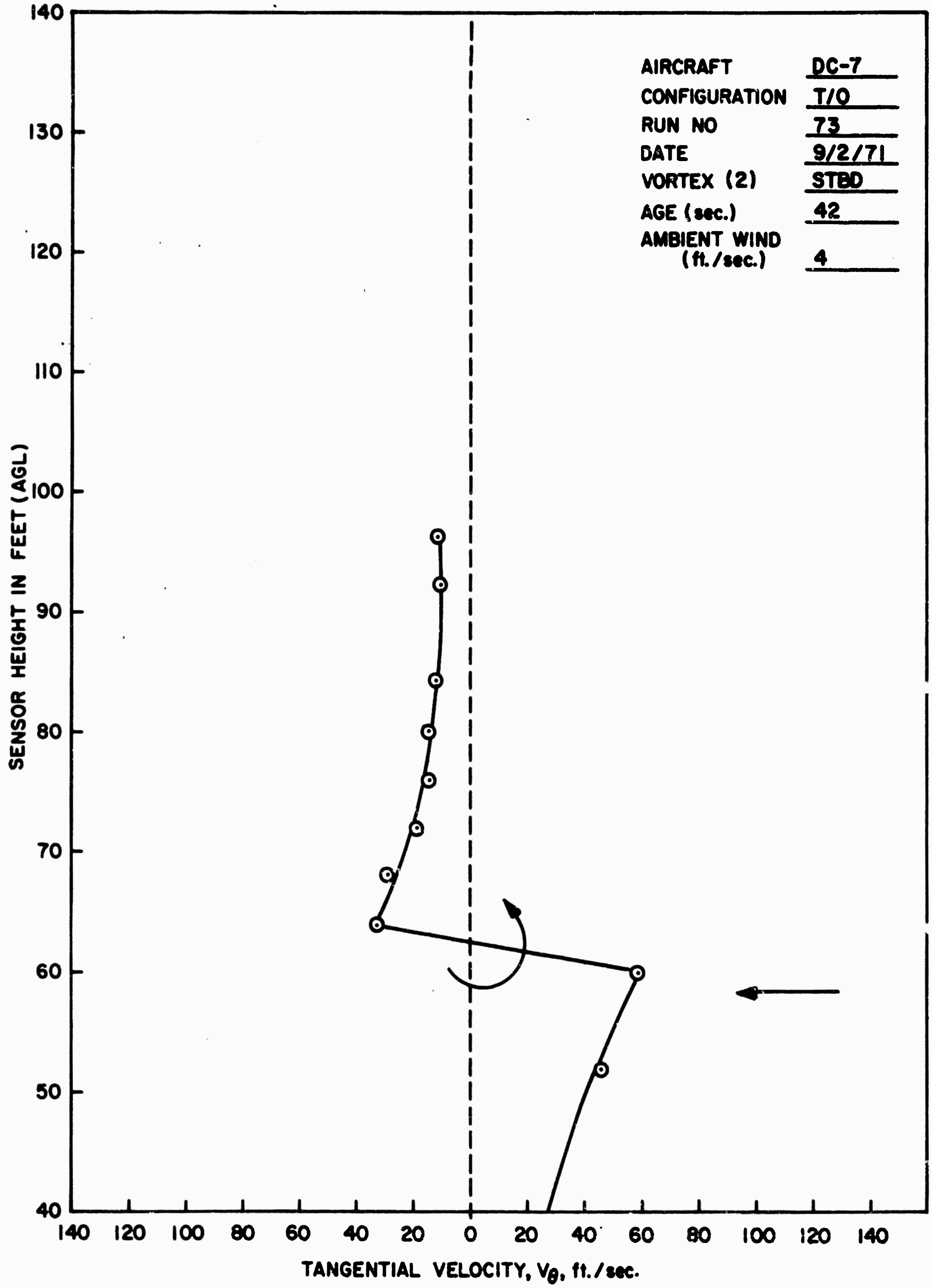

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 70
DATE 9/1/71
VORTEX STBD
AGE (sec.) 34
AMBIENT WIND (ft./sec.) 12
SENSOR HEIGHT IN FEET (AGL)
100
90
80
70
60
50
40
30
20
10
0
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, Vθ, ft./sec.

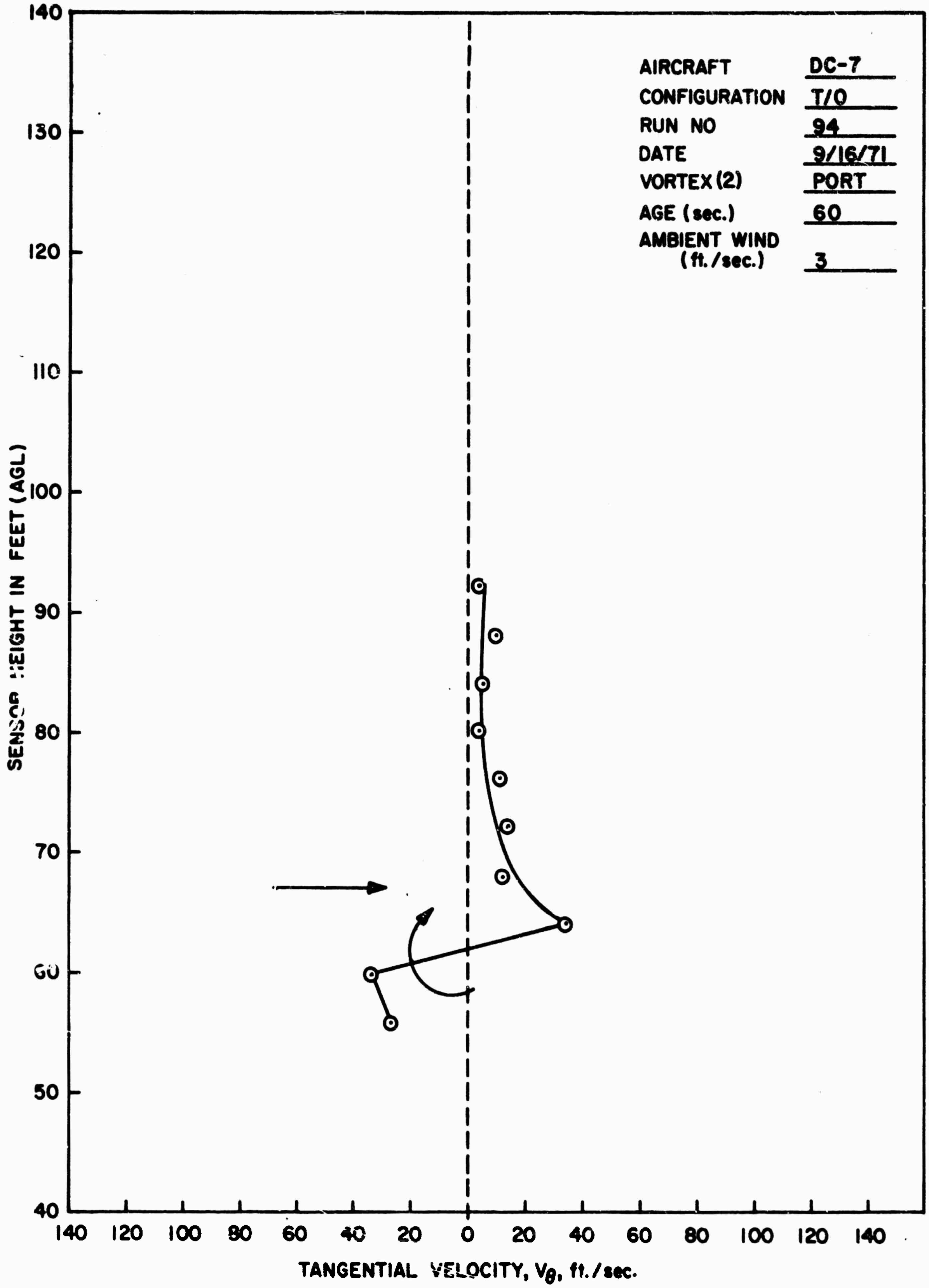

AIRCRAFT DC-7
CONFIGURATION TO
RUN NO 97
DATE 9/16/71
VORTEX (2) PORT
AGE (sec.) 34.0
AMBIENT WIND (ft./sec.) 59
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

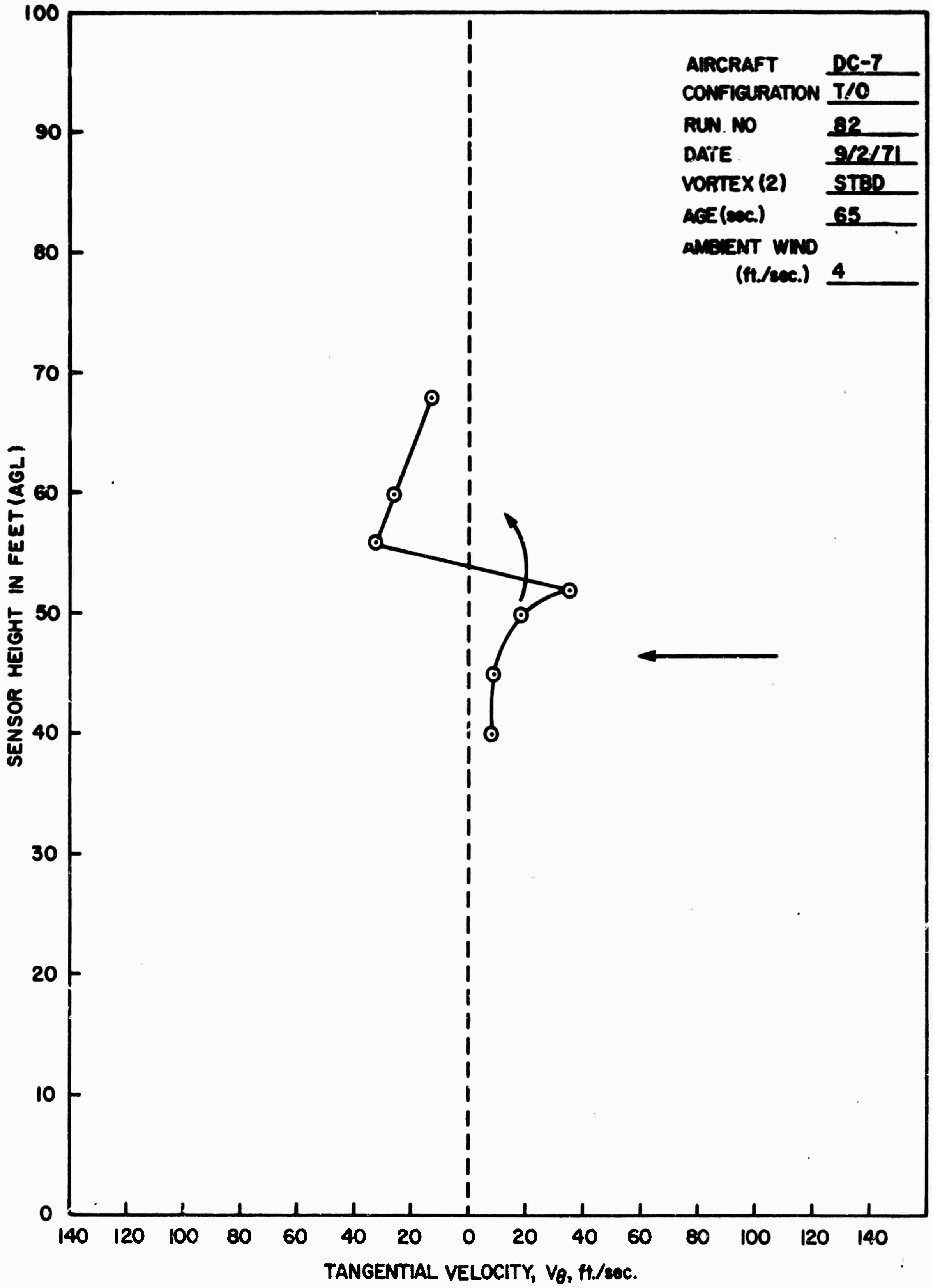


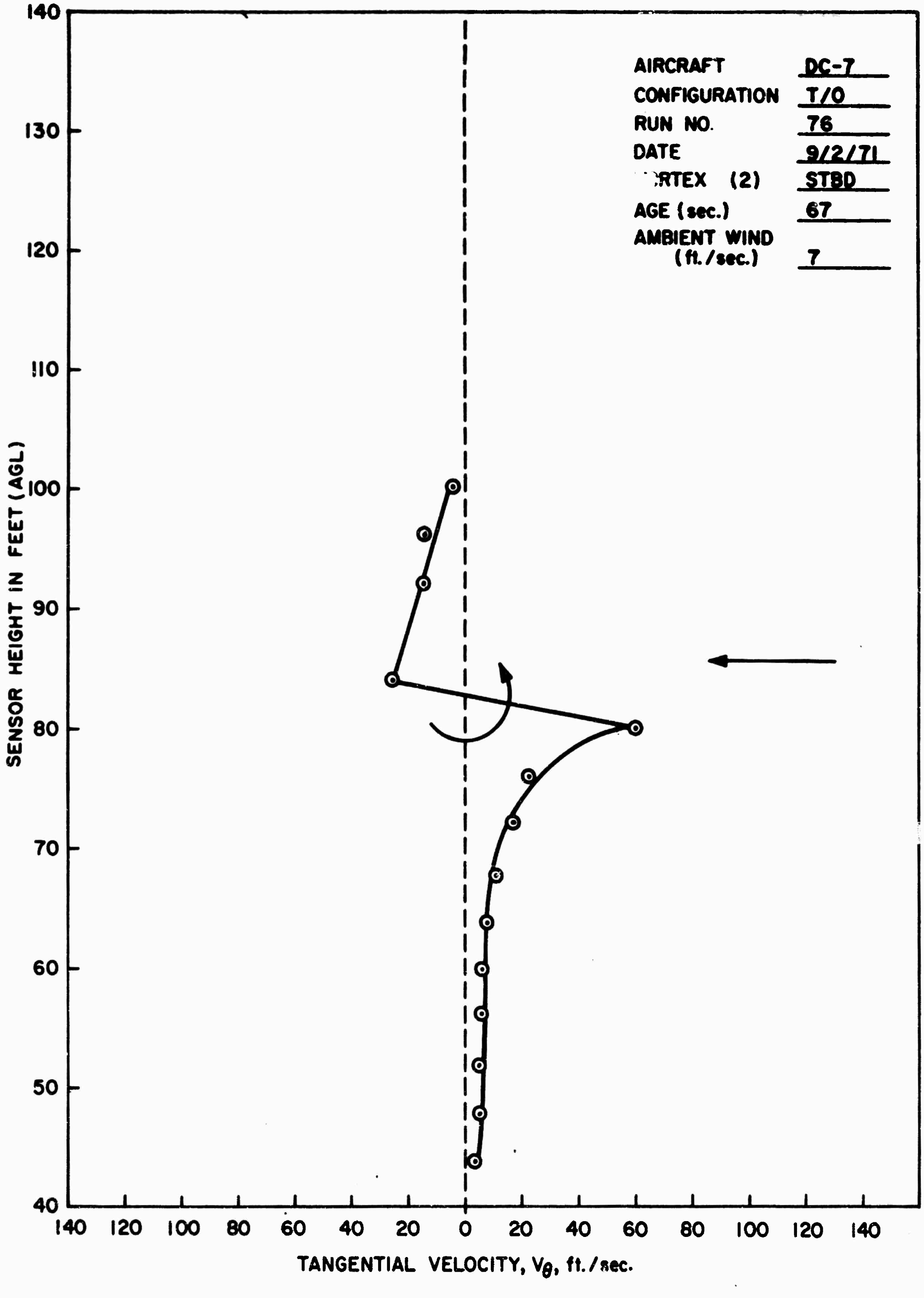
AIRCRAFT DC-7
CONFIGURATION T/O
RUN. NO 100
DATE 9/16/71
VORTEX (2) PT.
AGE (sec.) 34.5
AMBIENT WIND (ft./sec.) 5.9
SENSOR HEIGHT IN FEET (AGL)
100
90
80
70
60
50
40
30
20
10
0
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

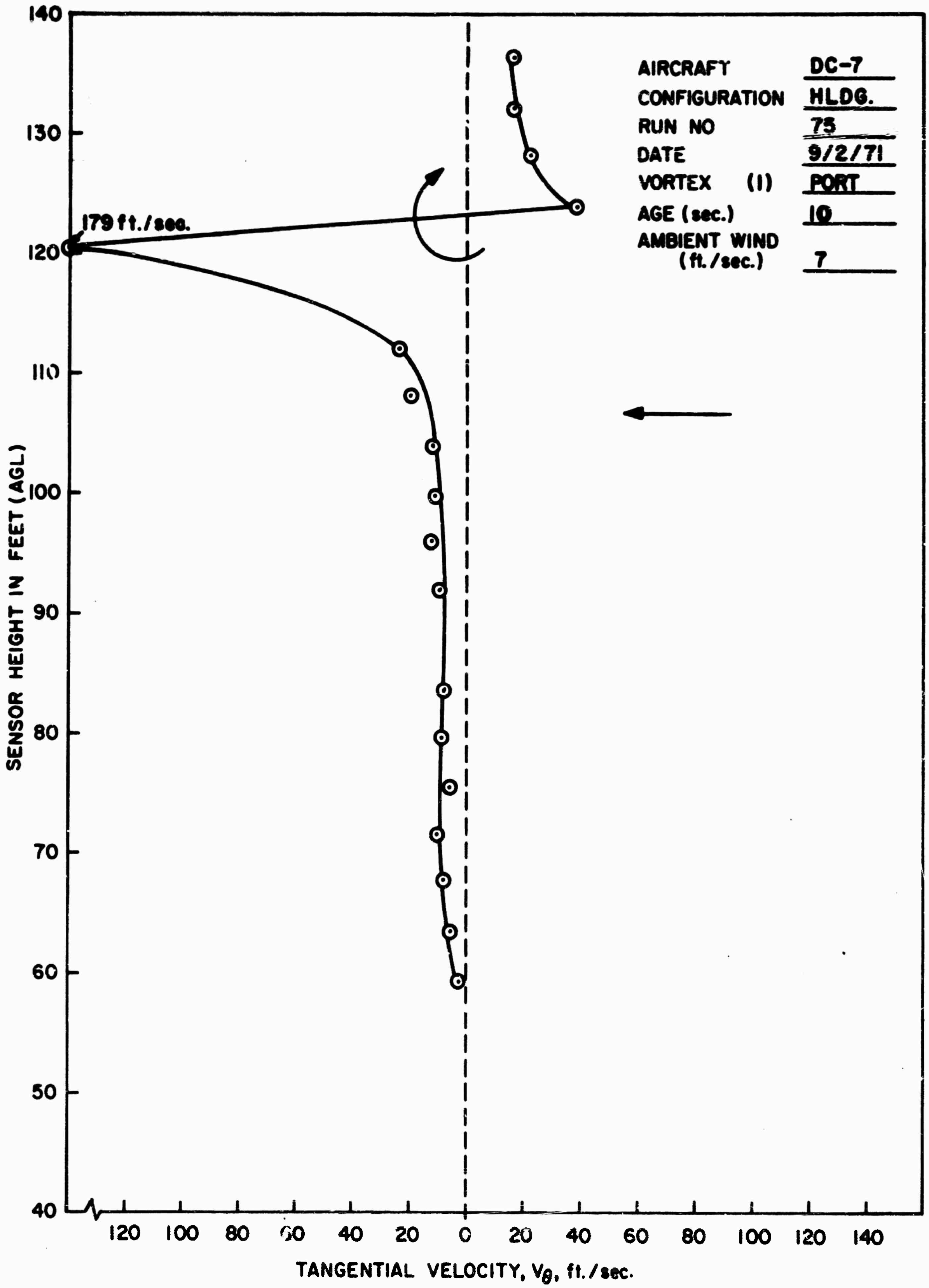

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 85
DATE 9/16/71
VORTEX (2) PT
AGE (sec.) 35
AMBIENT WIND (ft./sec.) 8.8
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

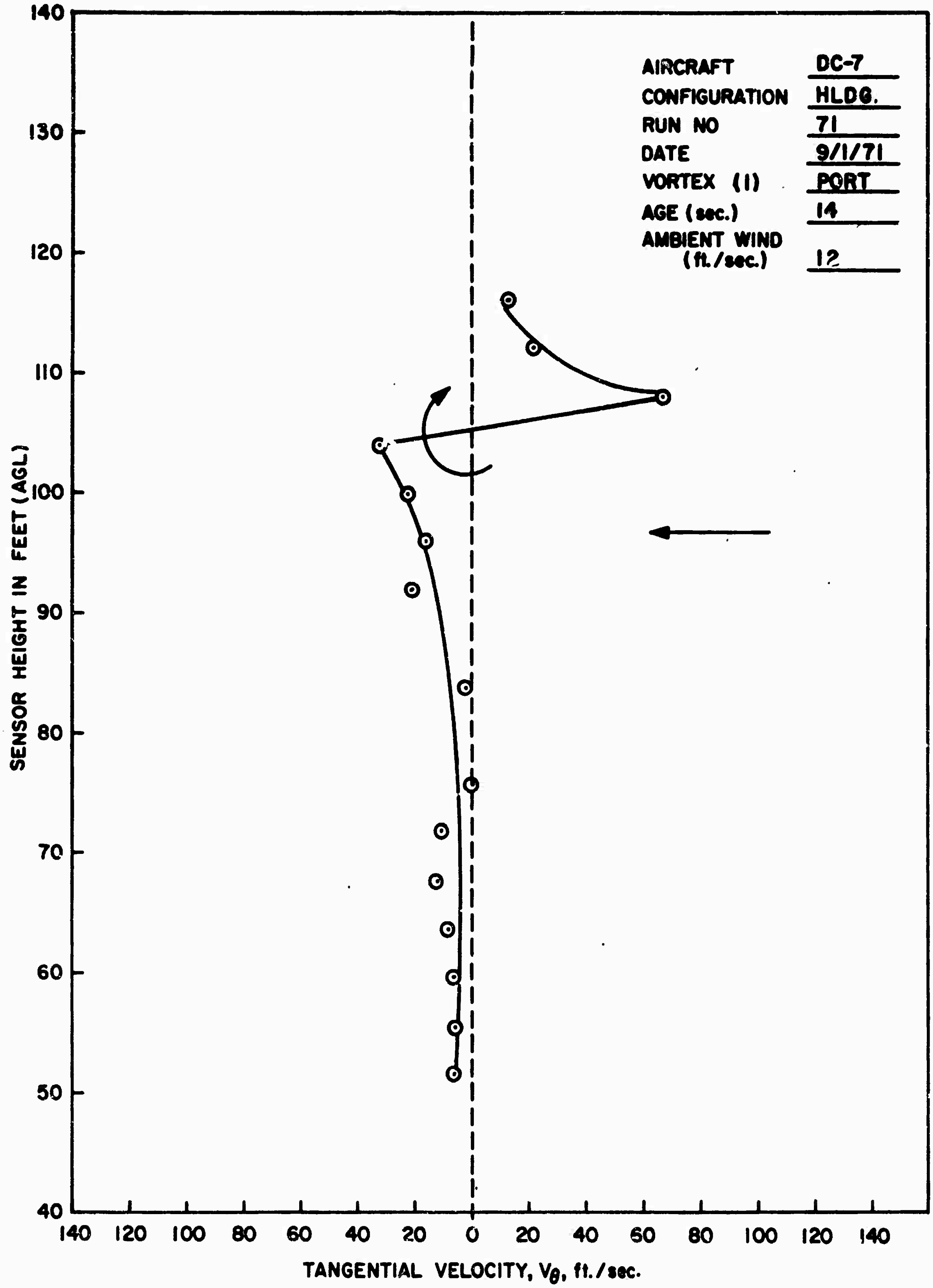

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 73
DATE 9/2/71
VORTEX (2) STBD
AGE (sec.) 42
AMBIENT WIND (ft./sec.) 4
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

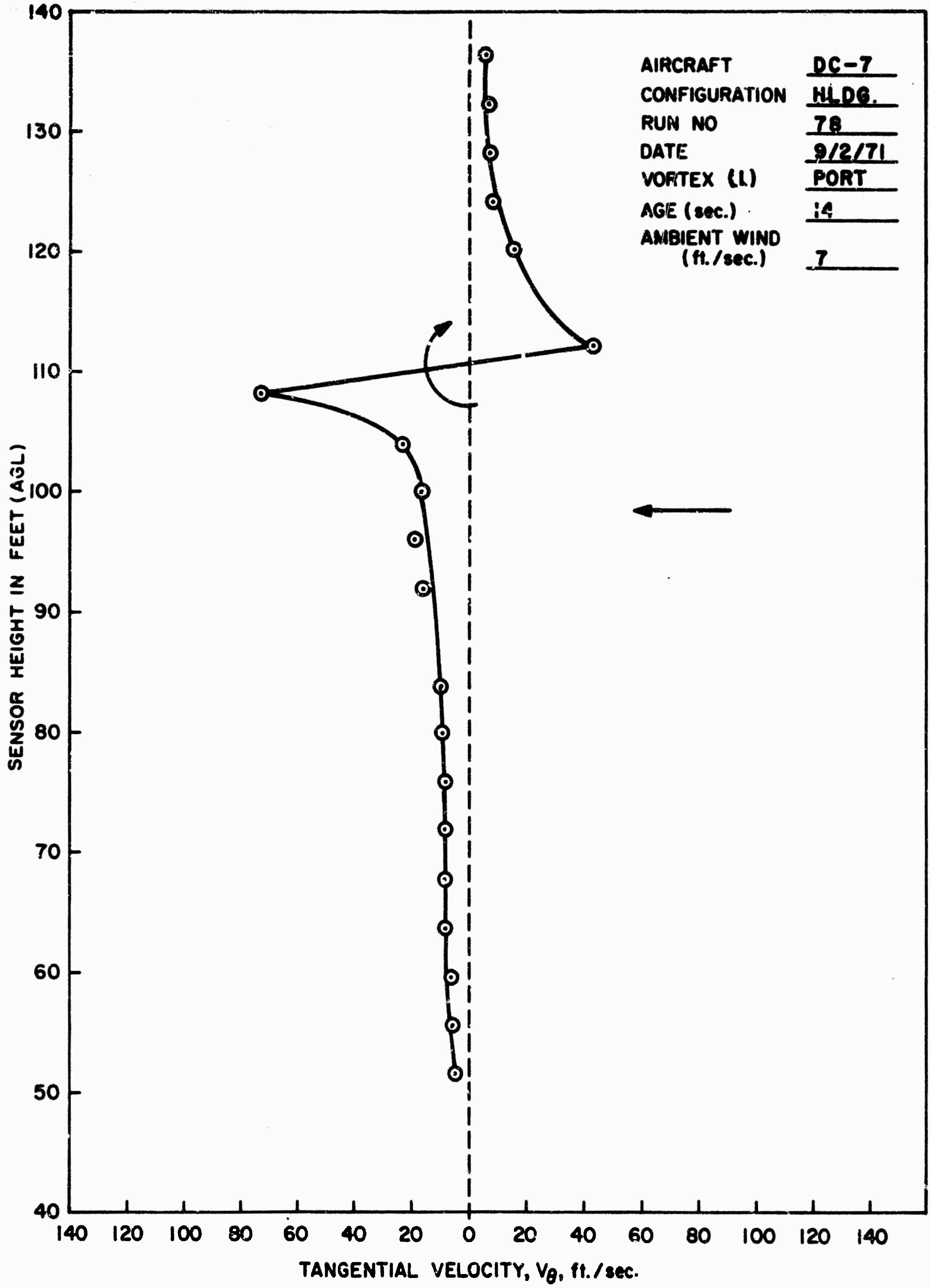

AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO 94
DATE 9/16/71
VORTEX (2) PORT
AGE (sec.) 60
AMBIENT WIND (ft./sec.) 3
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

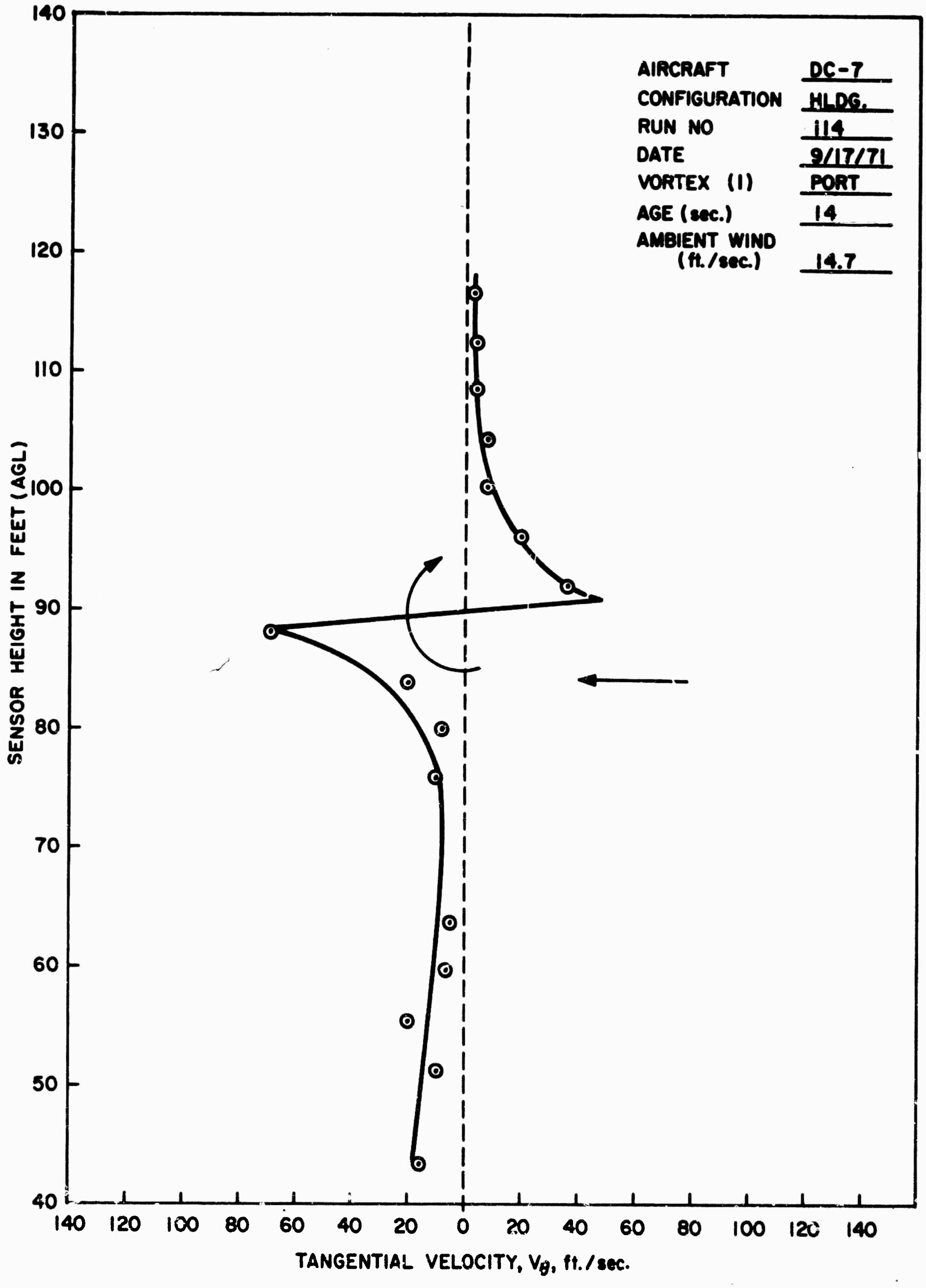

AIRCRAFT DC-7
CONFIGURATION T/O
RUN. NO 82
DATE 9/2/71
VORTEX (2) STBD
AGE (sec.) 65
AMBIENT WIND (ft./sec.) 4
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, Vθ, ft./sec.
0
10
20
30
40
50
60
70
80
90
100
140
120
100
80
60
40
20
0
20
40
60
80
100
120
140


AIRCRAFT DC-7
CONFIGURATION T/O
RUN NO. 76
DATE 9/2/71
ᐧ:RTEX (2) STBD
AGE (sec.) 67
AMBIENT WIND (ft./sec.) 7
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.

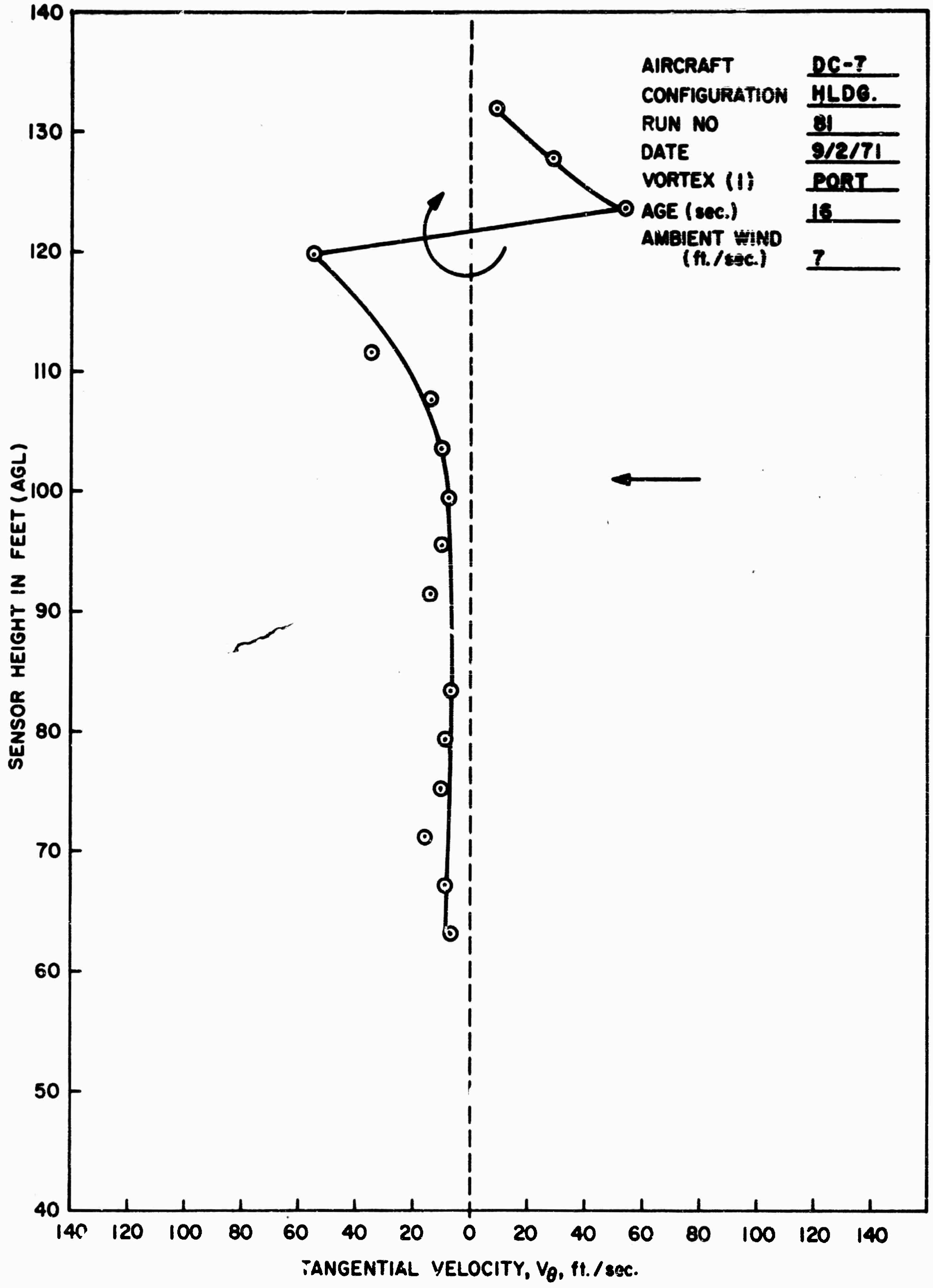

AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 75
DATE 9/2/71
VORTEX (1) PORT
AGE (sec.) 10
AMBIENT WIND (ft./sec.) 7
179 ft./sec.
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 71
DATE 9/1/71
VORTEX (1) PORT
AGE (sec.) 14
AMBIENT WIND (ft./sec.) 12
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.

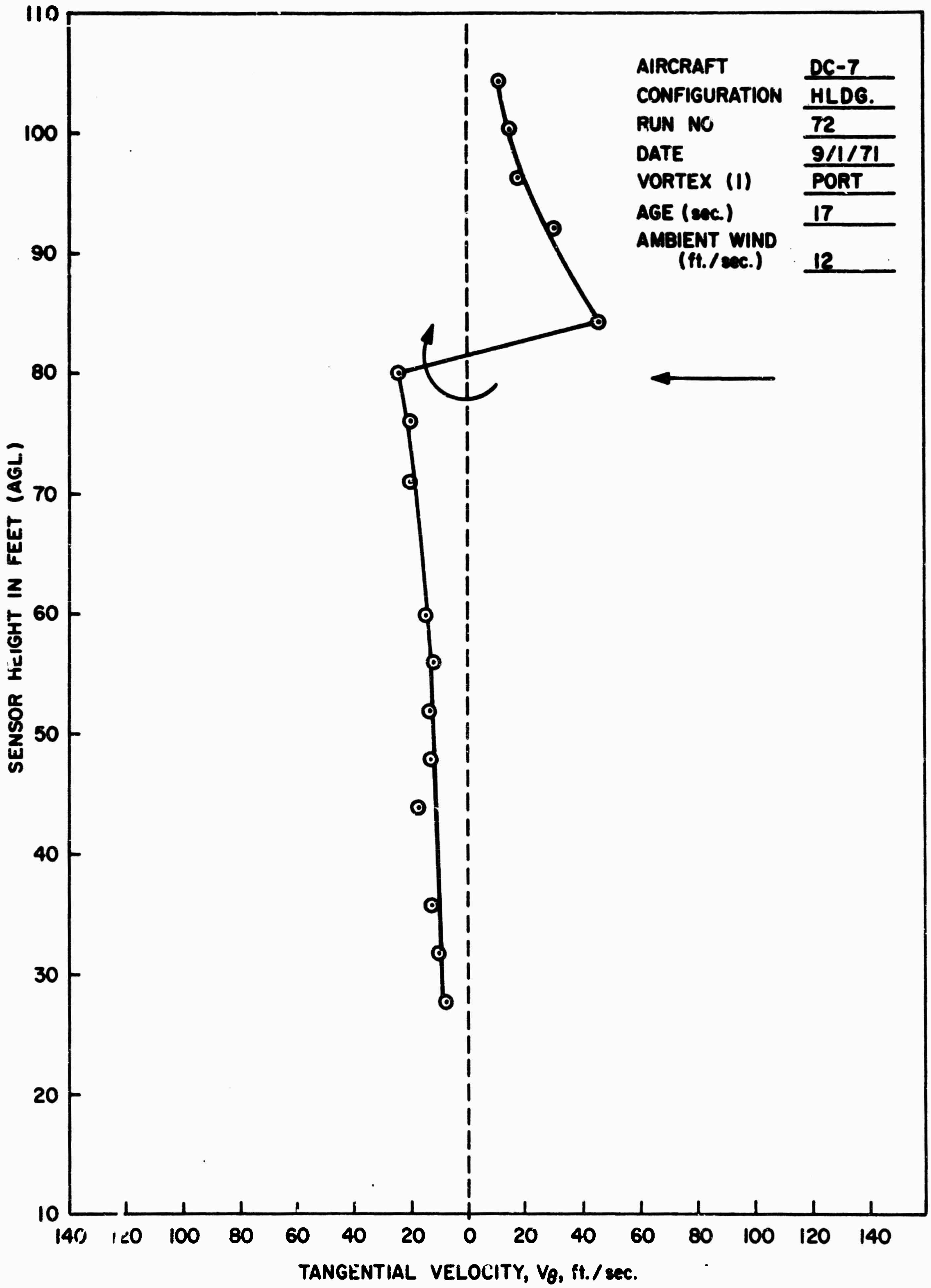

AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 78
DATE 9/2/71
VORTEX (L) PORT
AGE (sec.) 14
AMBIENT WIND (ft./sec.) 7
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

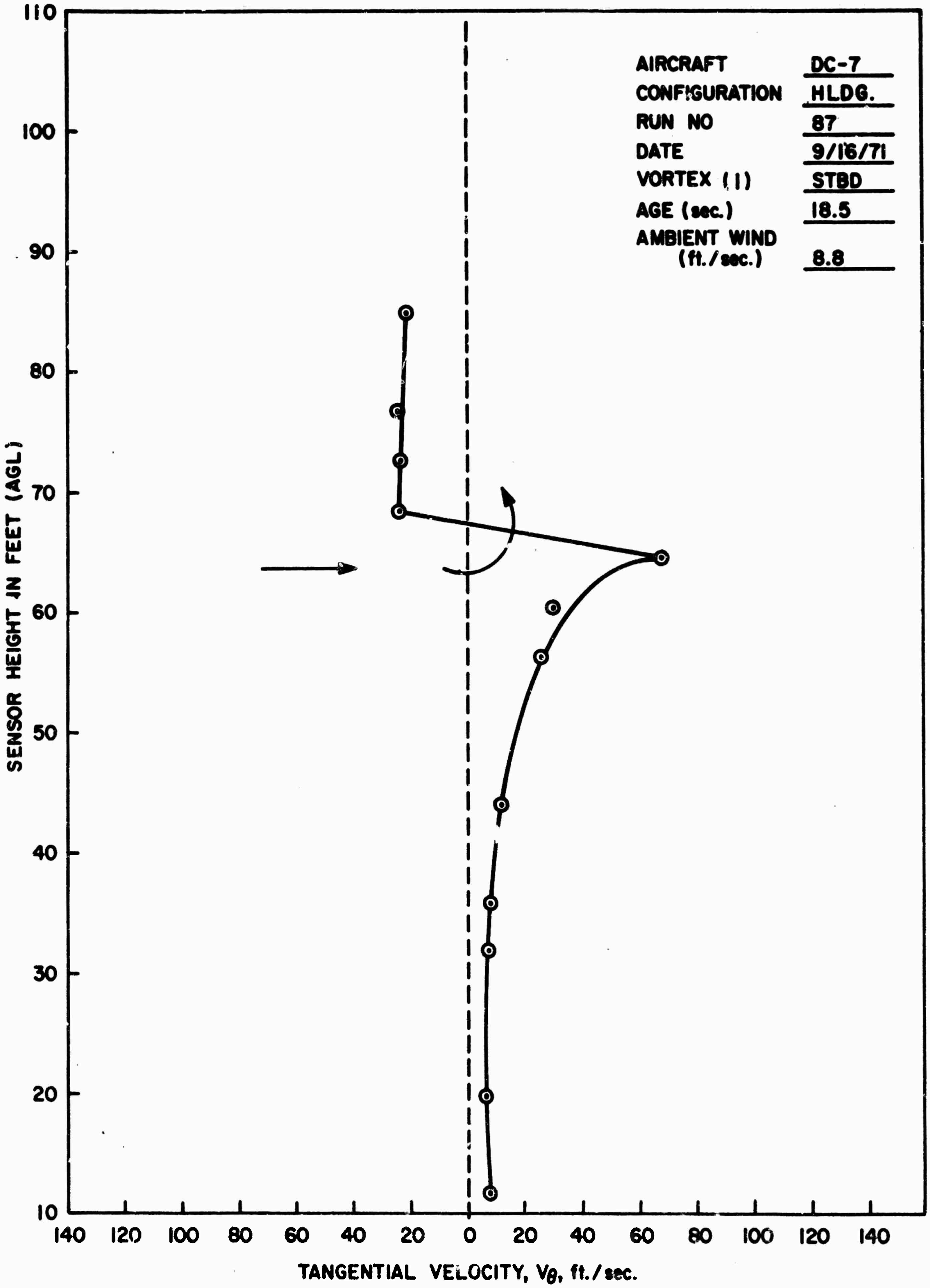


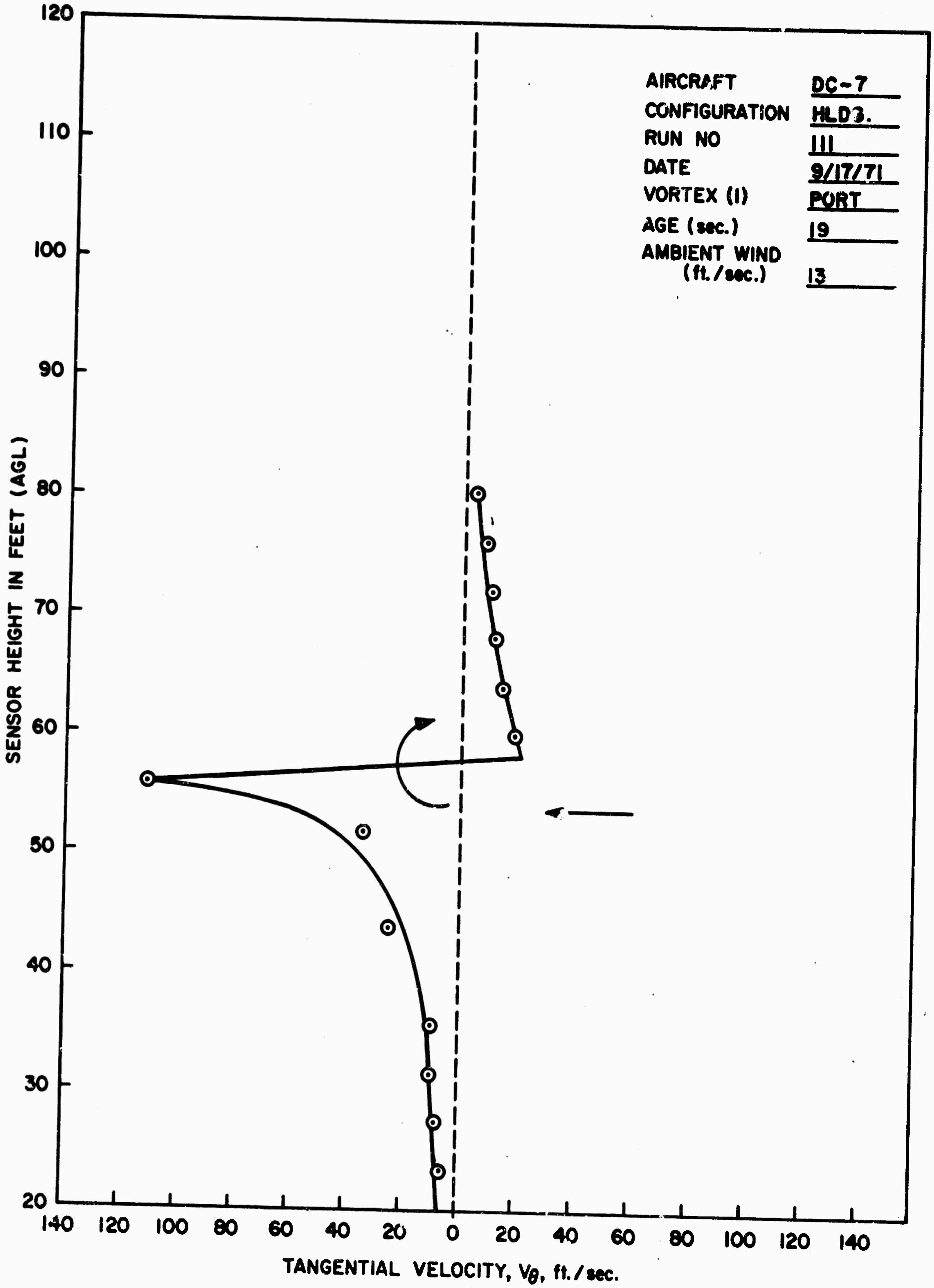
AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 114
DATE 9/17/71
VORTEX (1) PORT
AGE (sec.) 14
AMBIENT WIND (ft./sec.) 14.7
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

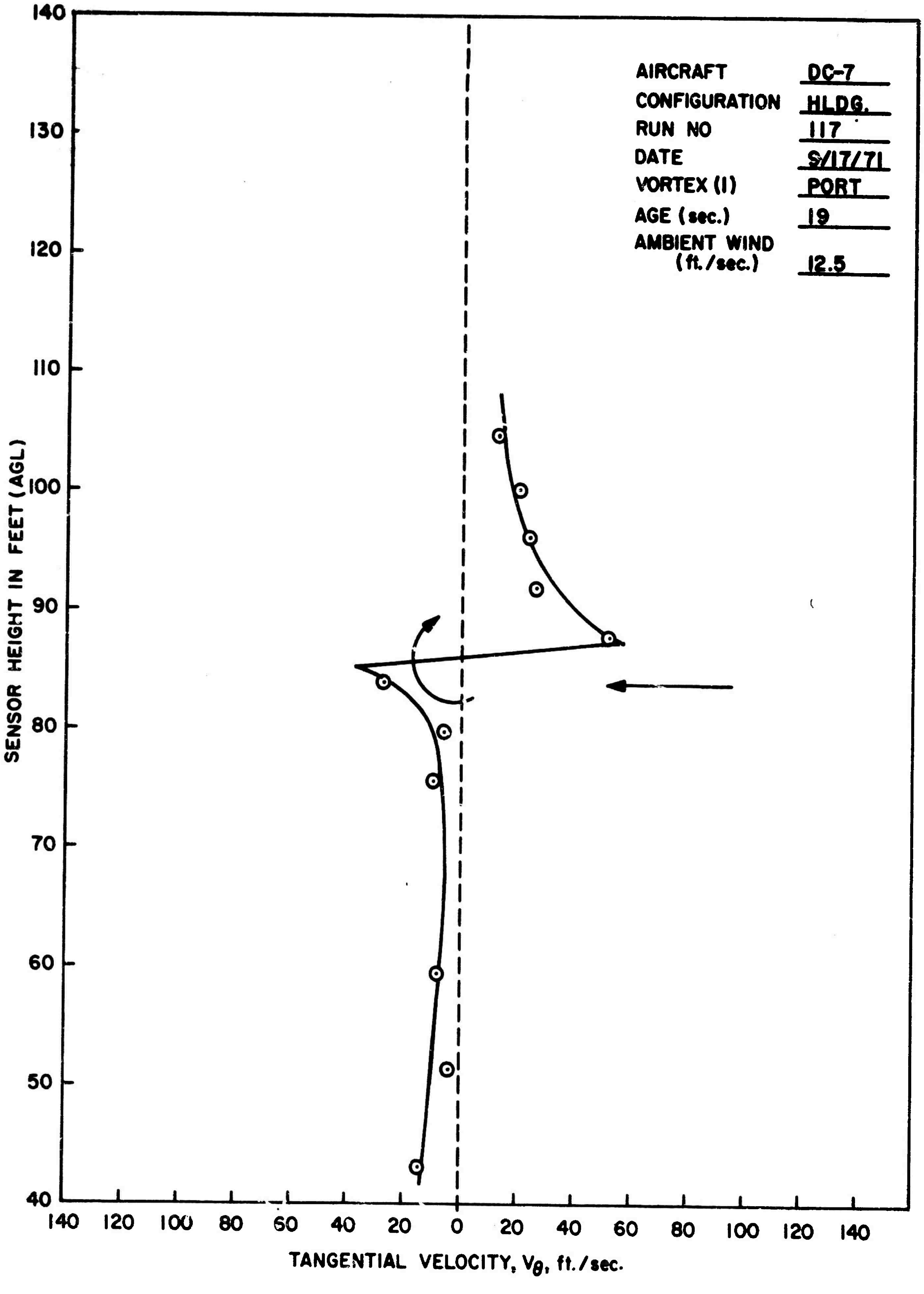


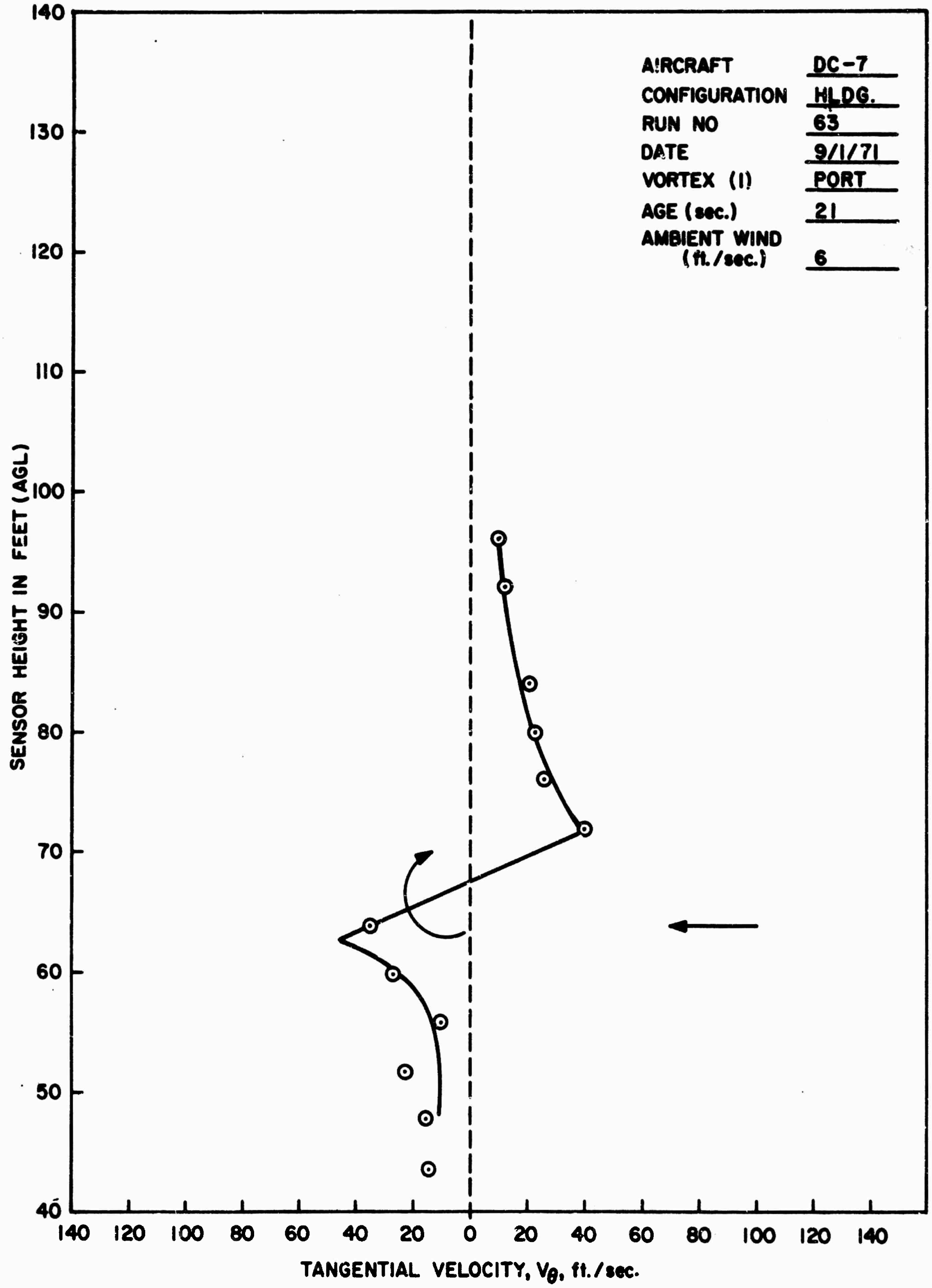
AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 81
DATE 9/2/71
VORTEX (1) PORT
AGE (sec.) 16
AMBIENT WIND (ft./sec.) 7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

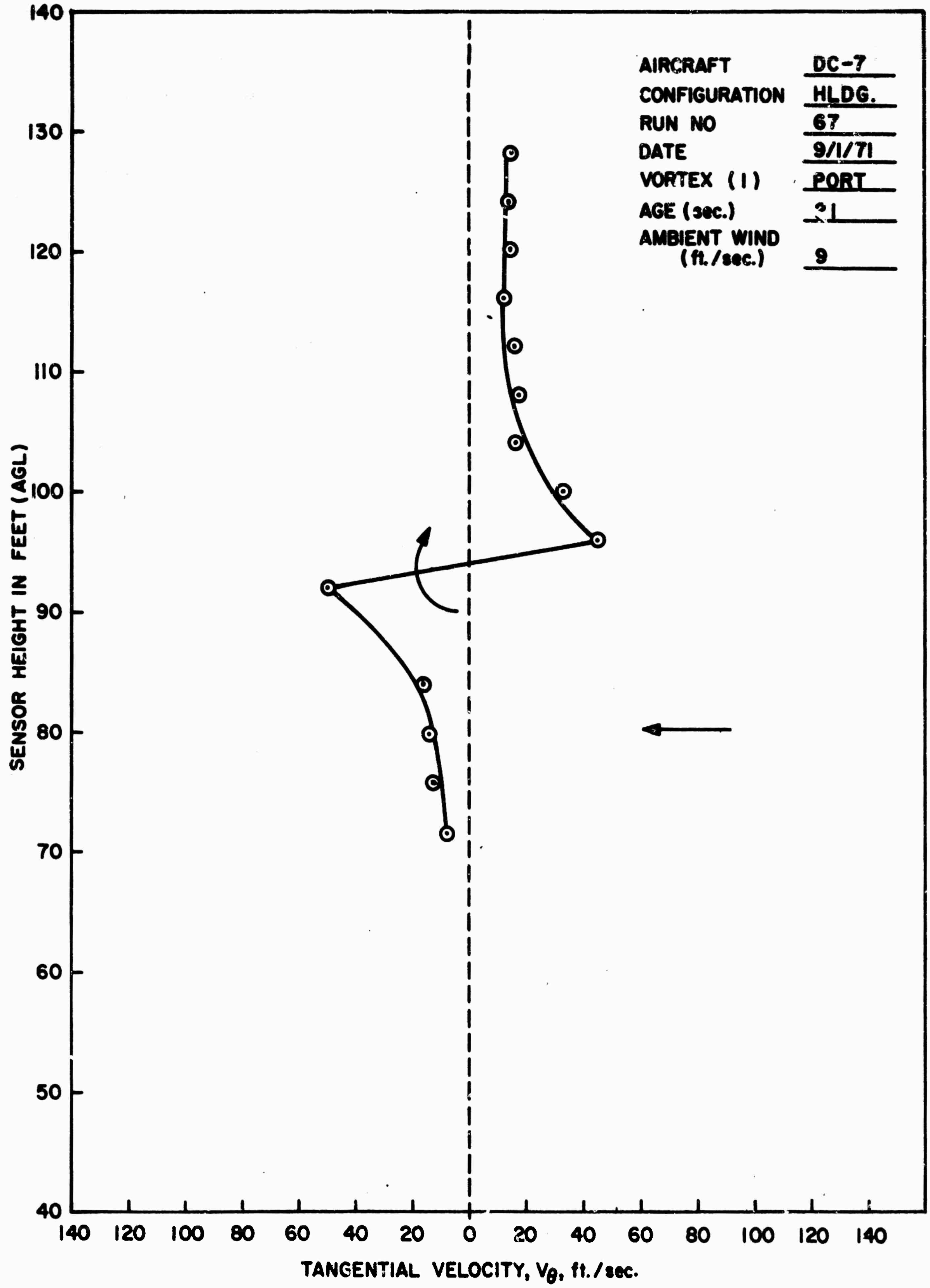

AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 72
DATE 9/1/71
VORTEX (1) PORT
AGE (sec.) 17
AMBIENT WIND (ft./sec.) 12
SENSOR HEIGHT IN FEET (AGL)
110
100
90
80
70
60
50
40
30
20
10
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

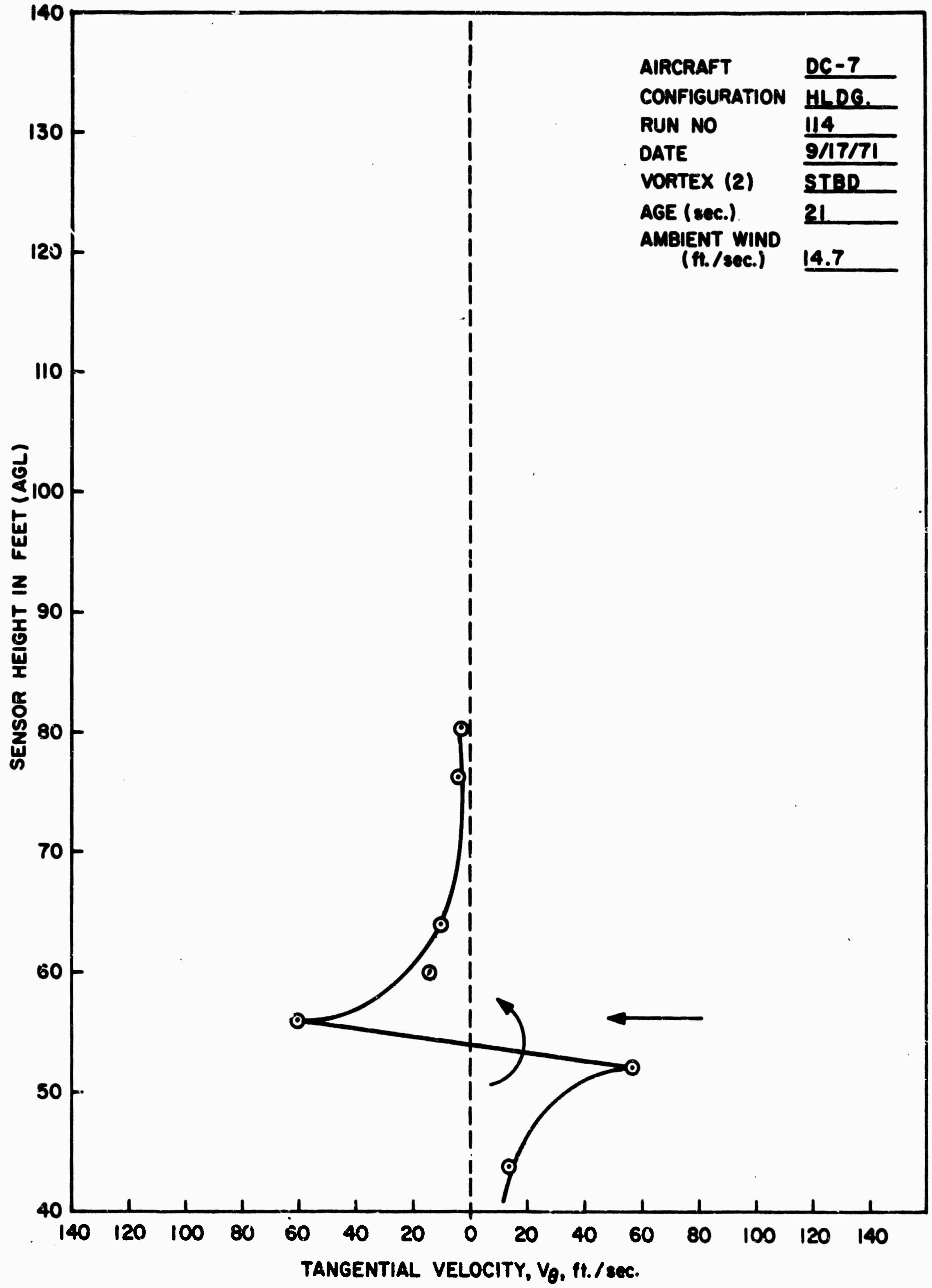

AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 87
DATE 9/16/71
VORTEX (1) STBD
AGE (sec.) 18.5
AMBIENT WIND (ft./sec.) 8.8
SENSOR HEIGHT IN FEET (AGL)
110
100
90
80
70
60
50
40
30
20
10
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION HLD3.
RUN NO 111
DATE 9/17/71
VORTEX (1) PORT
AGE (sec.) 19
AMBIENT WIND (ft./sec.) 13
SENSOR HEIGHT IN FEET (AGL)
120
110
100
90
80
70
60
50
40
30
20
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

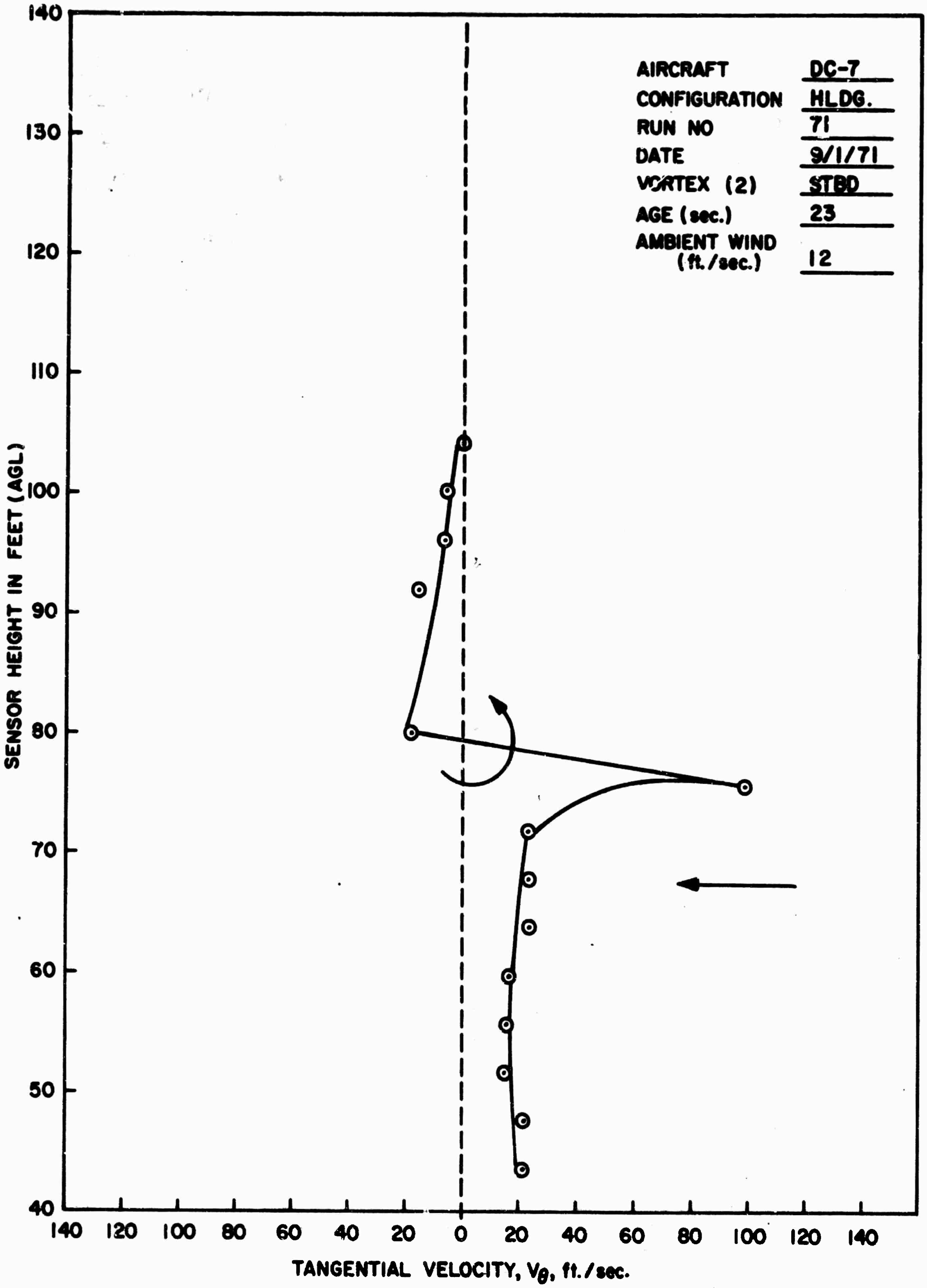

AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 117
DATE 9/17/71
VORTEX (1) PORT
AGE (sec.) 19
AMBIENT WIND (ft./sec.) 12.5
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140


AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 63
DATE 9/1/71
VORTEX (1) PORT
AGE (sec.) 21
AMBIENT WIND (ft./sec.) 6
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

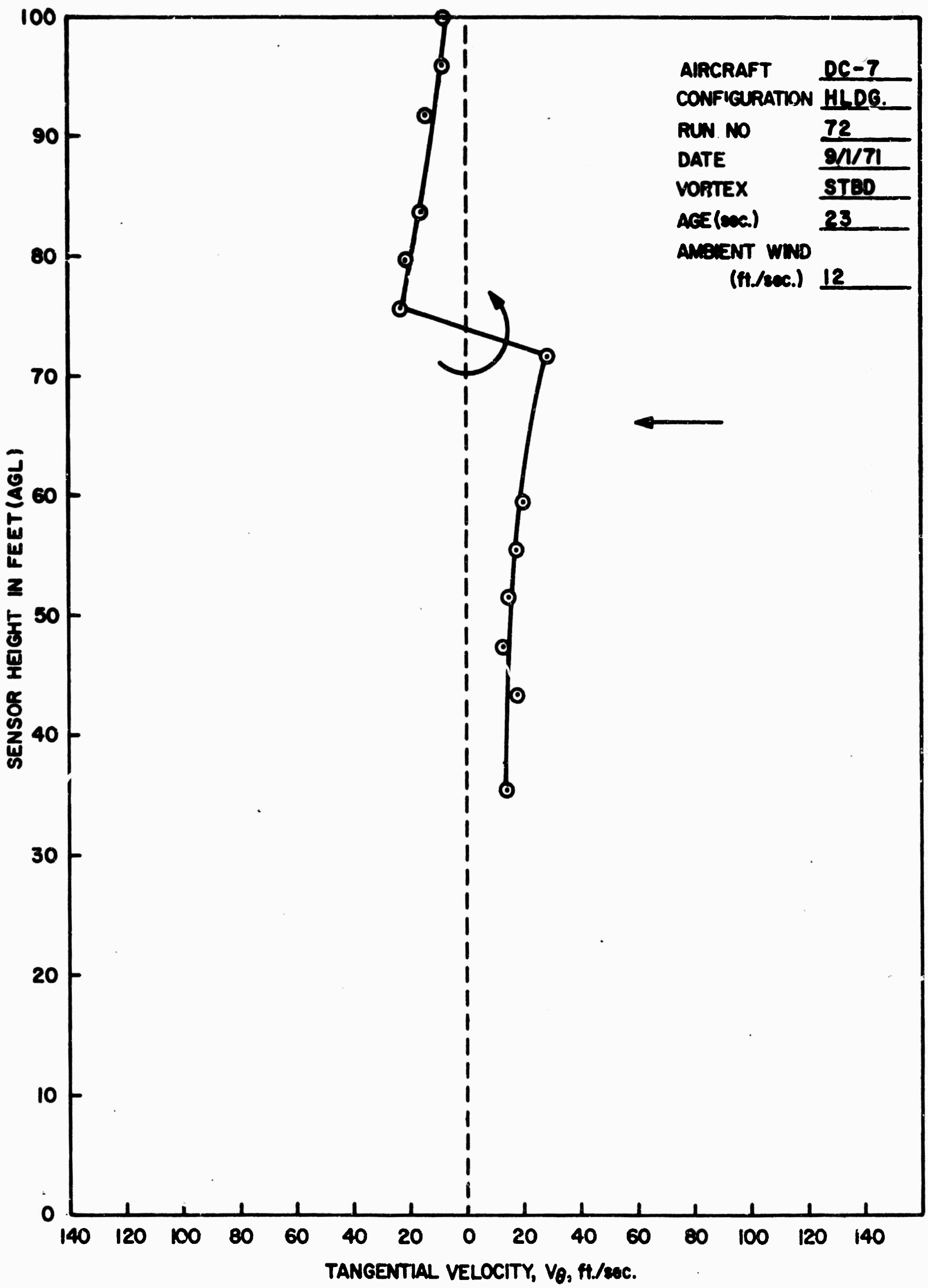

AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 67
DATE 9/1/71
VORTEX (1) PORT
AGE (sec.)
AMBIENT WIND (ft./sec.) 9
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



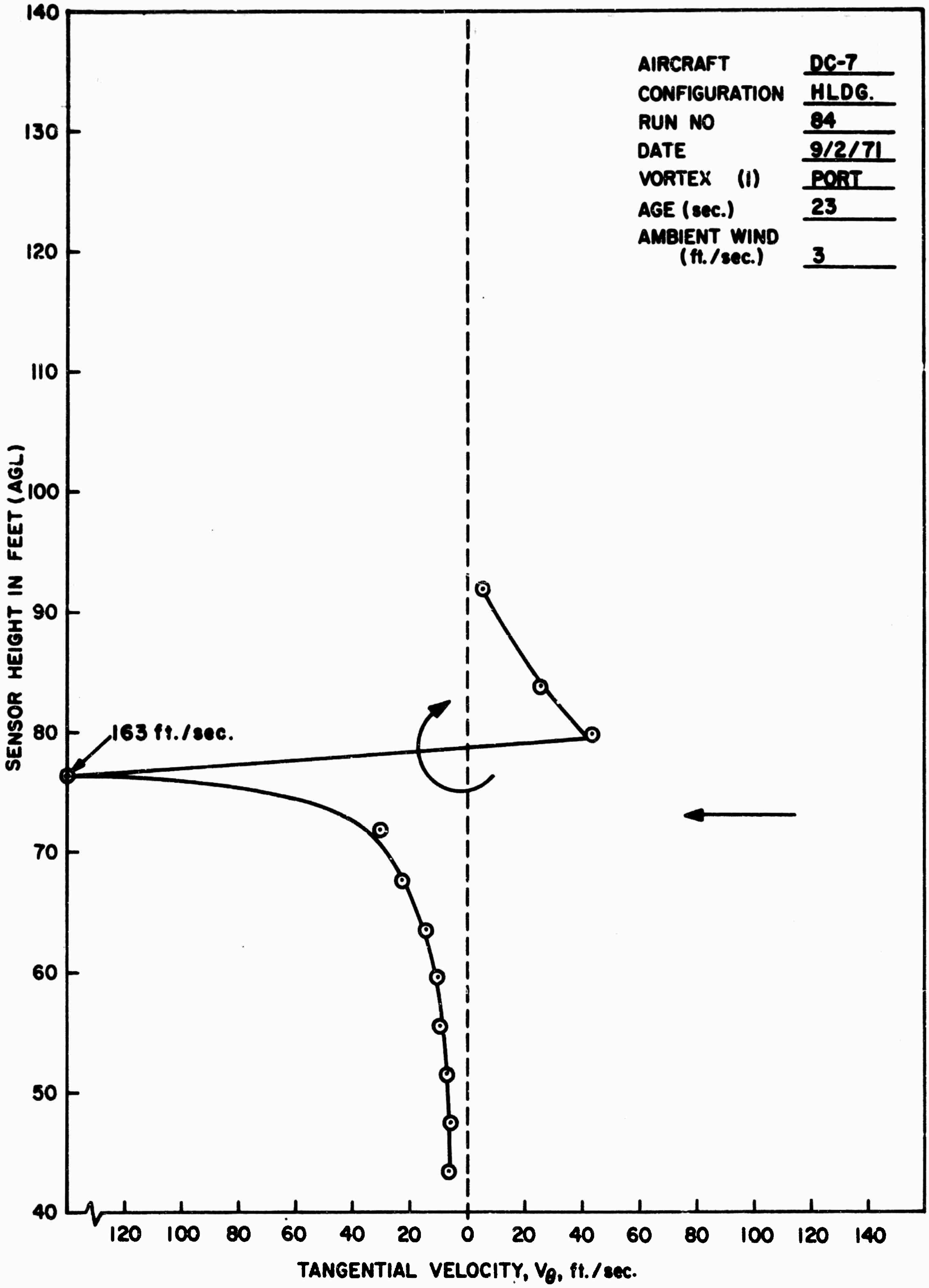
AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 114
DATE 9/17/71
VORTEX (2) STBD
AGE (sec.) 21
AMBIENT WIND (ft./sec.) 14.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, Vθ, ft./sec.



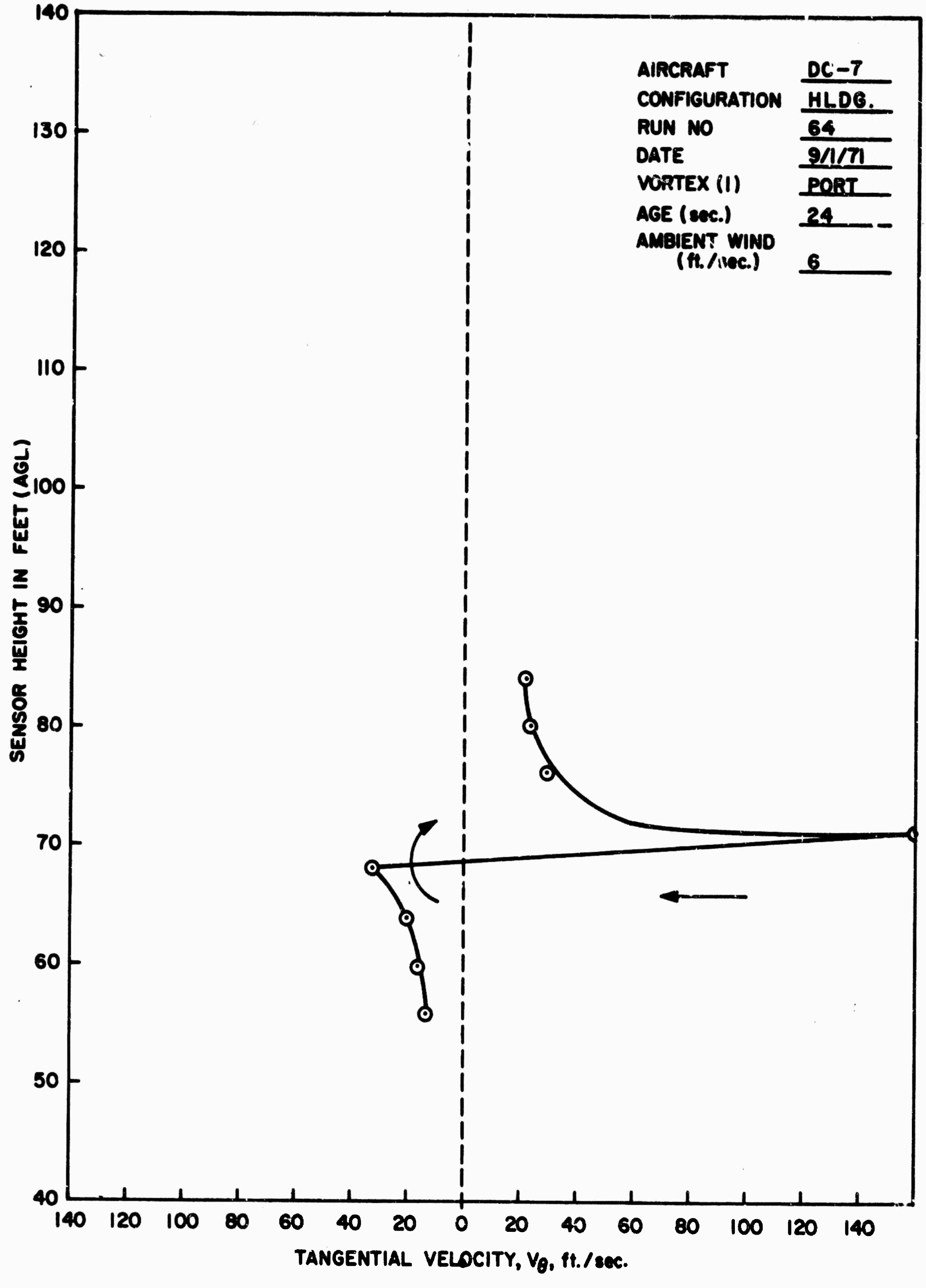
AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 71
DATE 9/1/71
VORTEX (2) STBD
AGE (sec.) 23
AMBIENT WIND (ft./sec.) 12
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



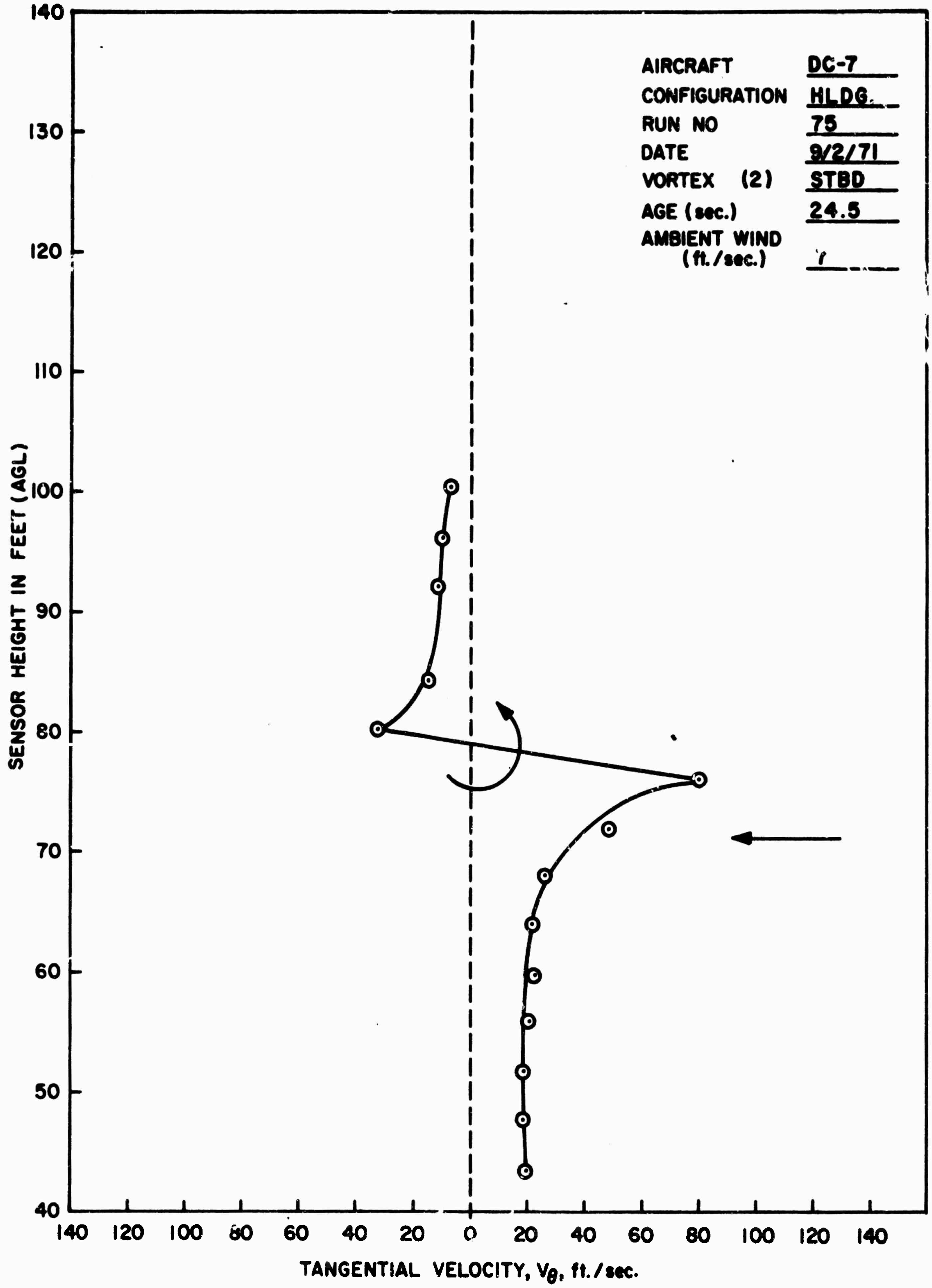
AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 72
DATE 9/1/71
VORTEX STBD
AGE (sec.) 23
AMBIENT WIND (ft./sec.) 12
SENSOR HEIGHT IN FEET (AGL)
100
90
80
70
60
50
40
30
20
10
0
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



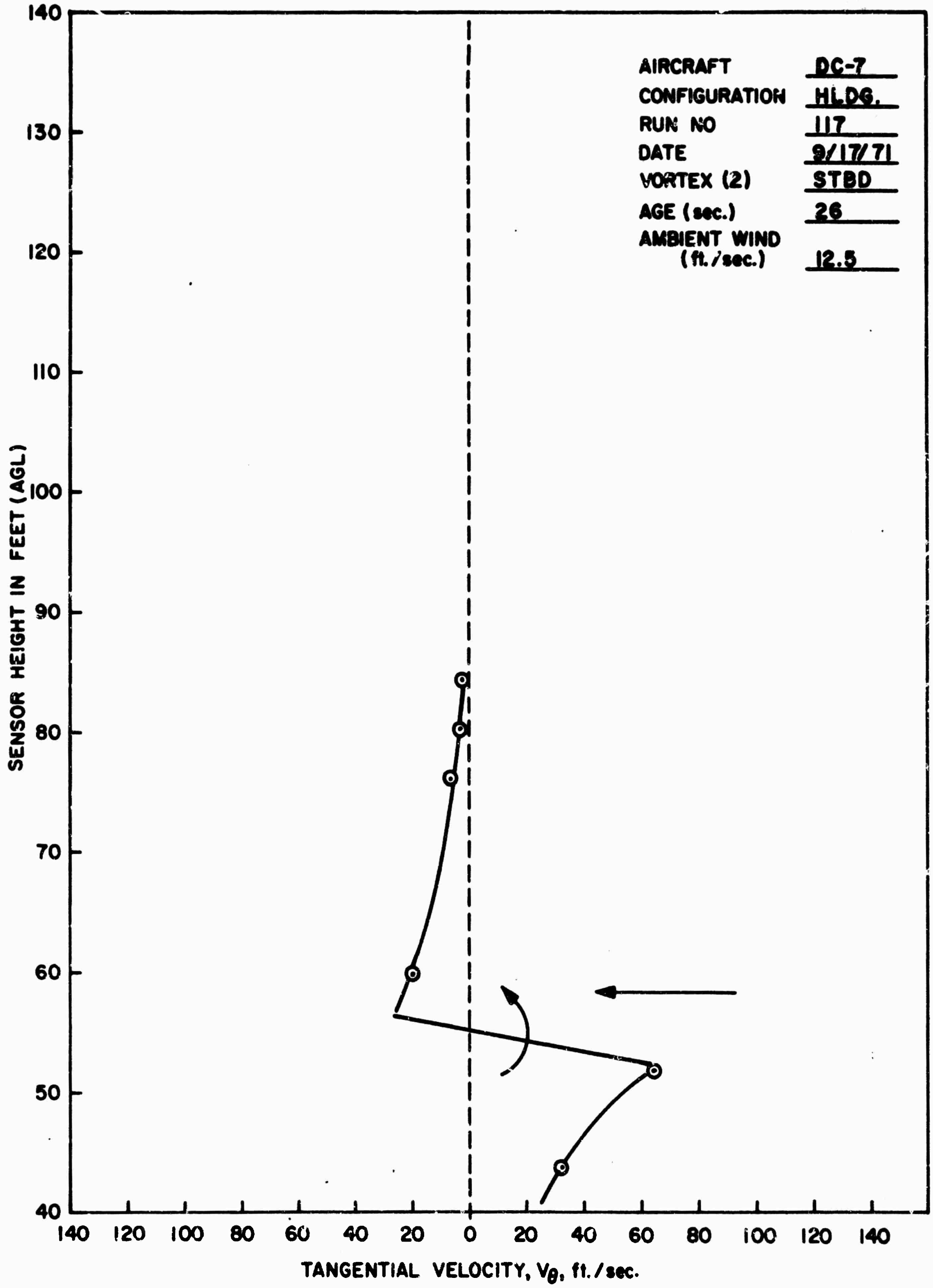
AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 84
DATE 9/2/71
VORTEX (1) PORT
AGE (sec.) 23
AMBIENT WIND (ft./sec.) 3
163 ft./sec.
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.



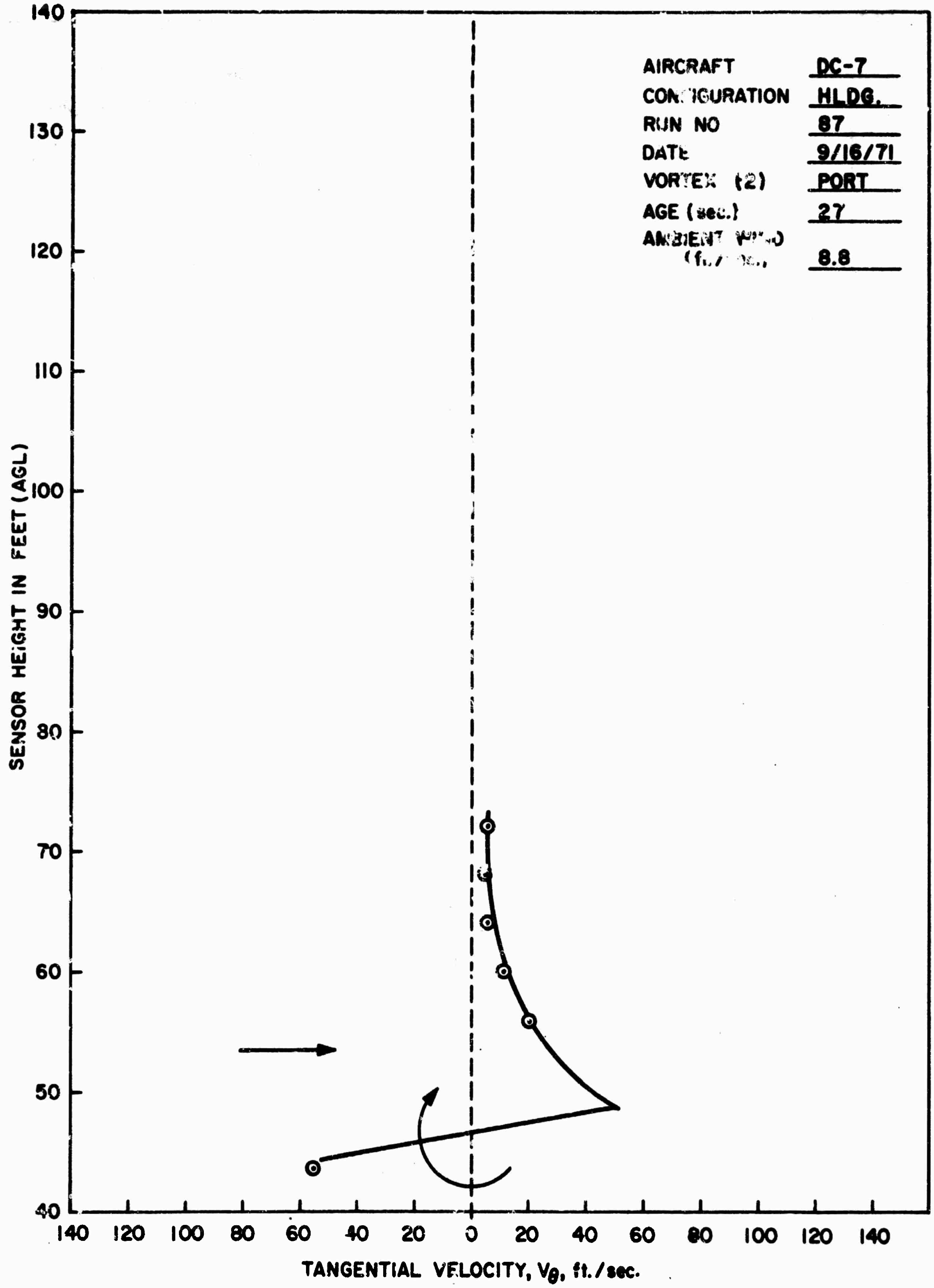
AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 64
DATE 9/1/71
VORTEX (1) PORT
AGE (sec.) 24
AMBIENT WIND (ft./sec.) 6
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



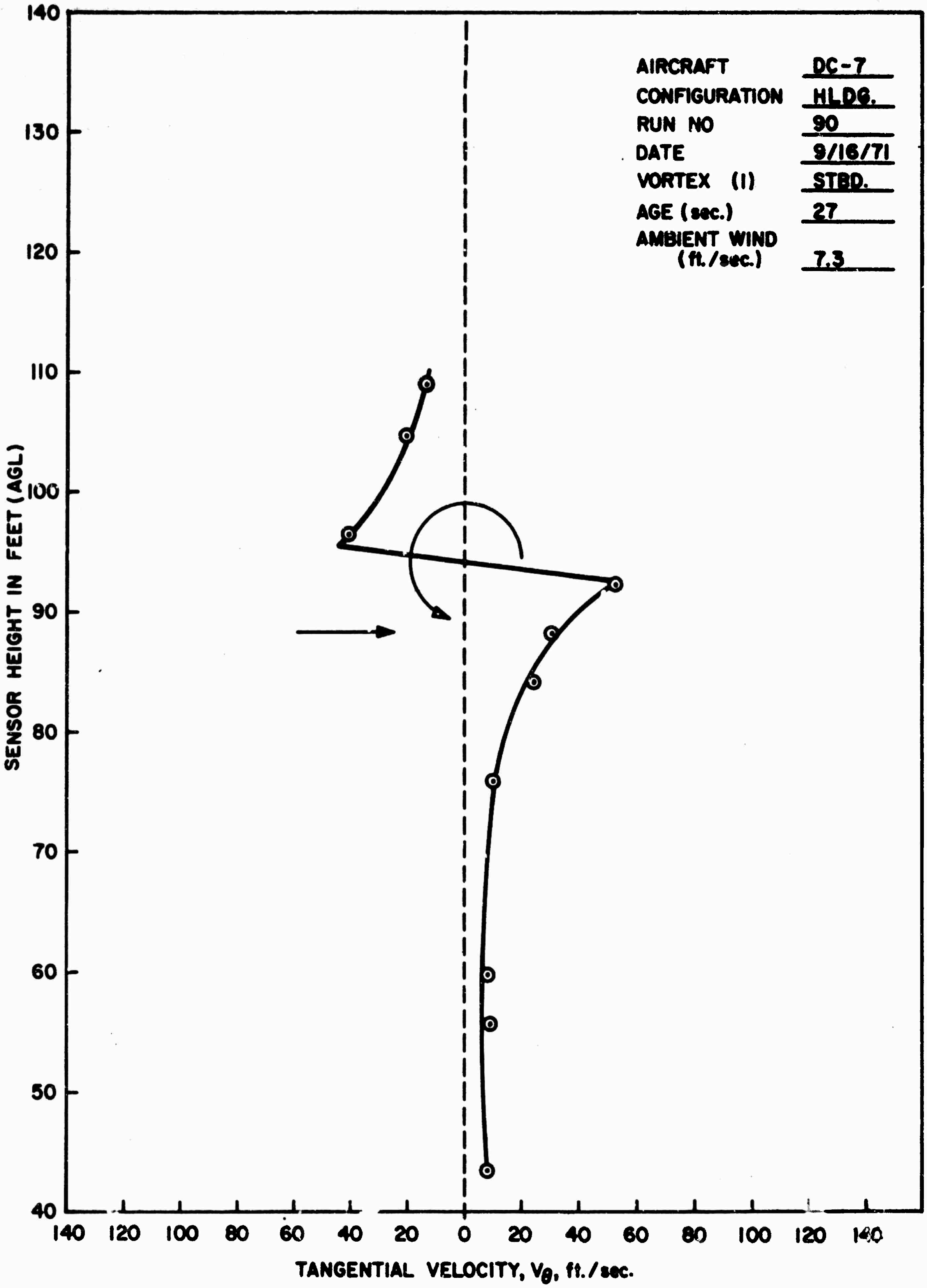
AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 75
DATE 9/2/71
VORTEX (2) STBD
AGE (sec.) 24.5
AMBIENT WIND (ft./sec.)
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



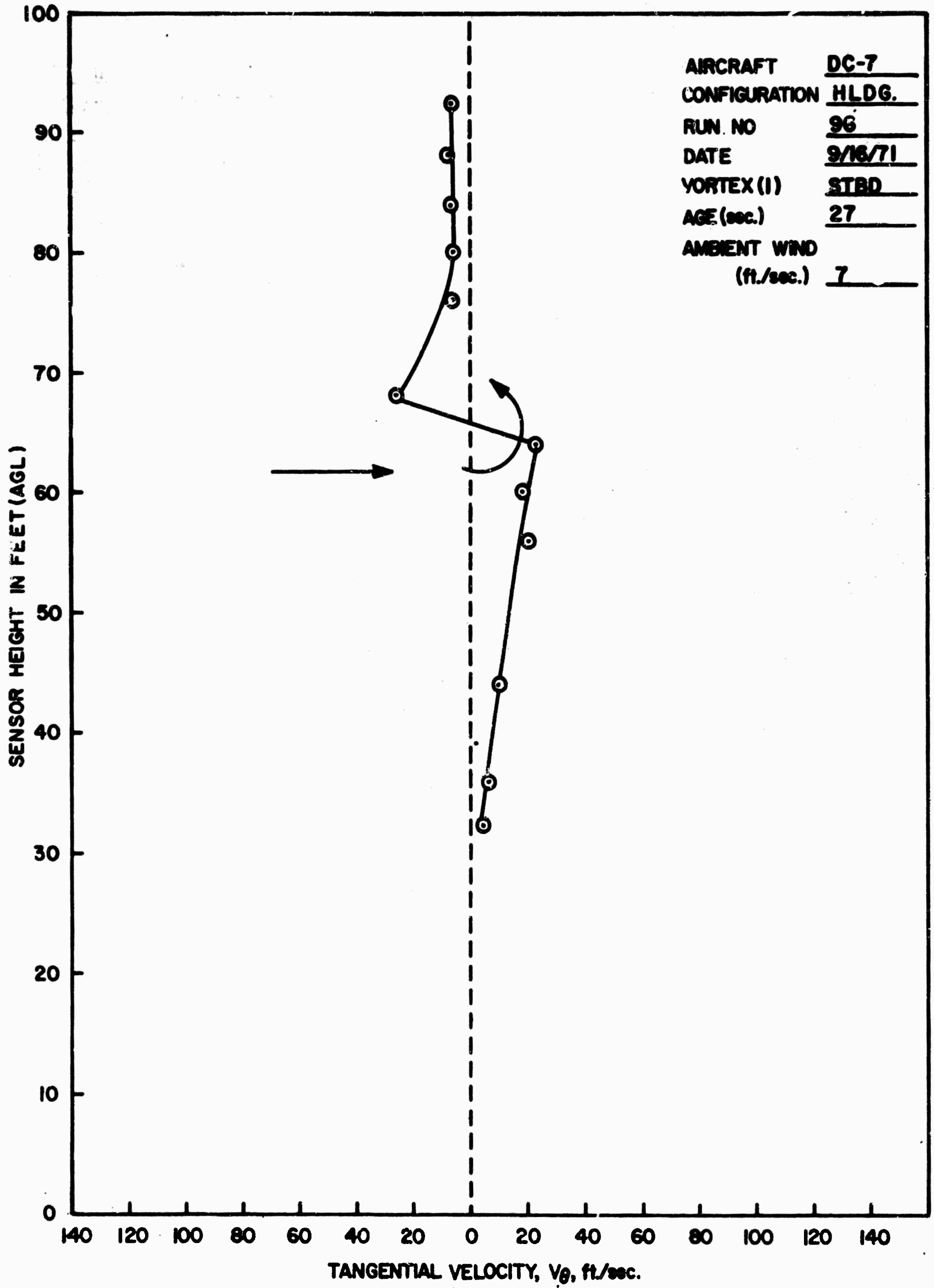
AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 117
DATE 9/17/71
VORTEX (2) STBD
AGE (sec.) 26
AMBIENT WIND (ft./sec.) 12.5
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



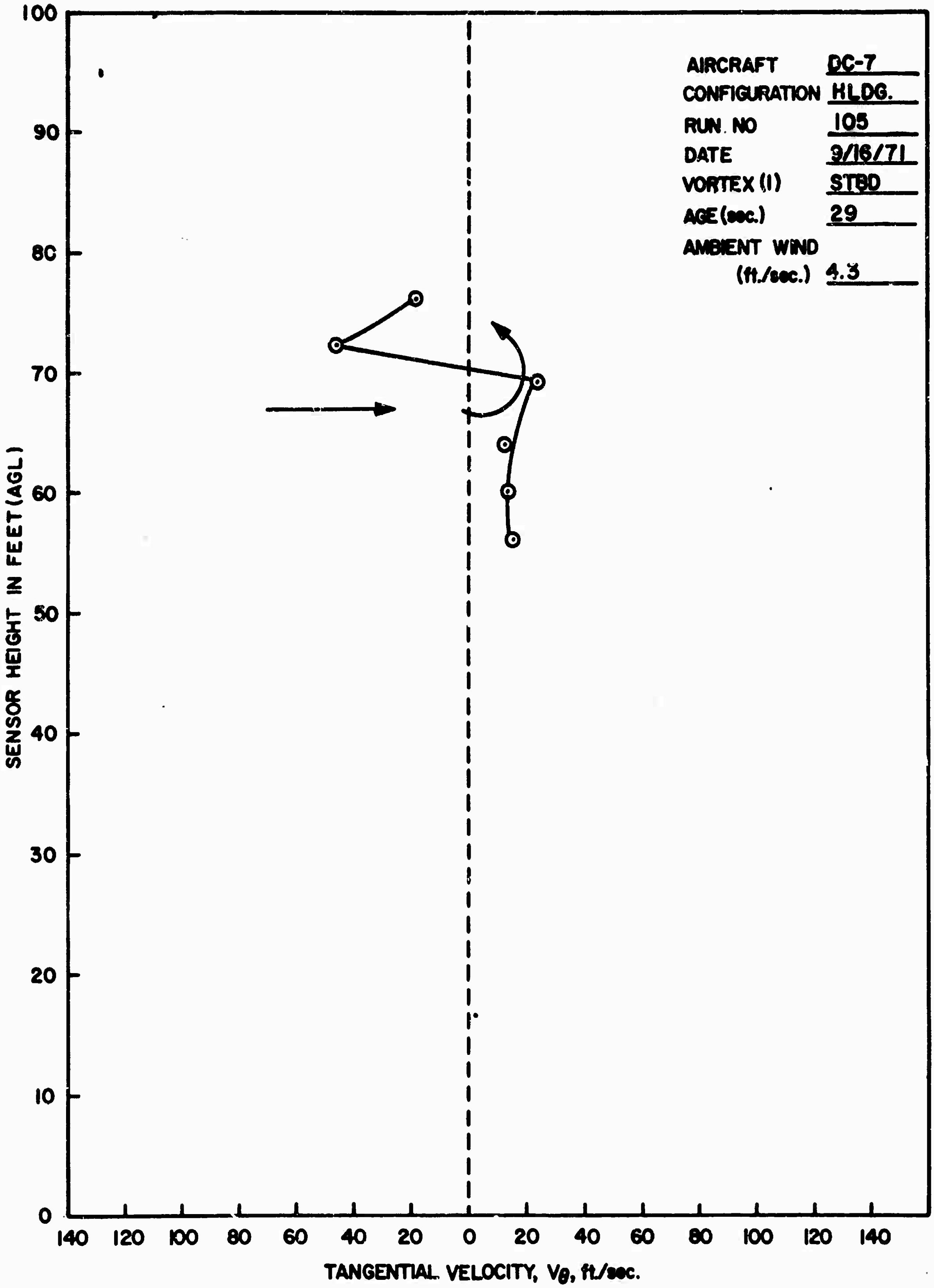
AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 87
DATE 9/16/71
VORTEX (2) PORT
AGE (sec.) 27
AMBIENT WIND (ft./sec.) 8.8
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140 130 120 110 100 90 80 70 60 50 40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140



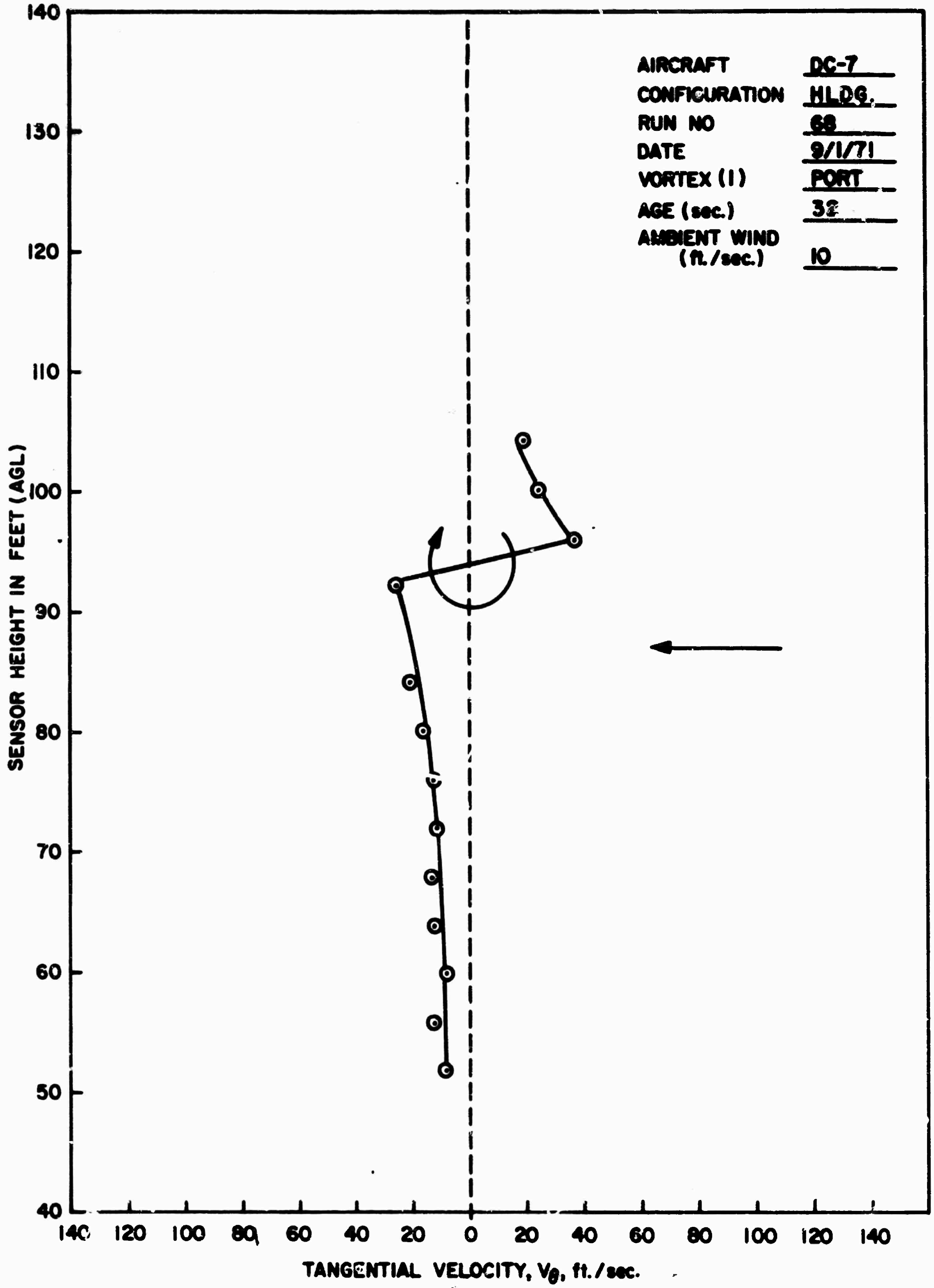
AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 90
DATE 9/16/71
VORTEX (1) STBD.
AGE (sec.) 27
AMBIENT WIND (ft./sec.) 7.3
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



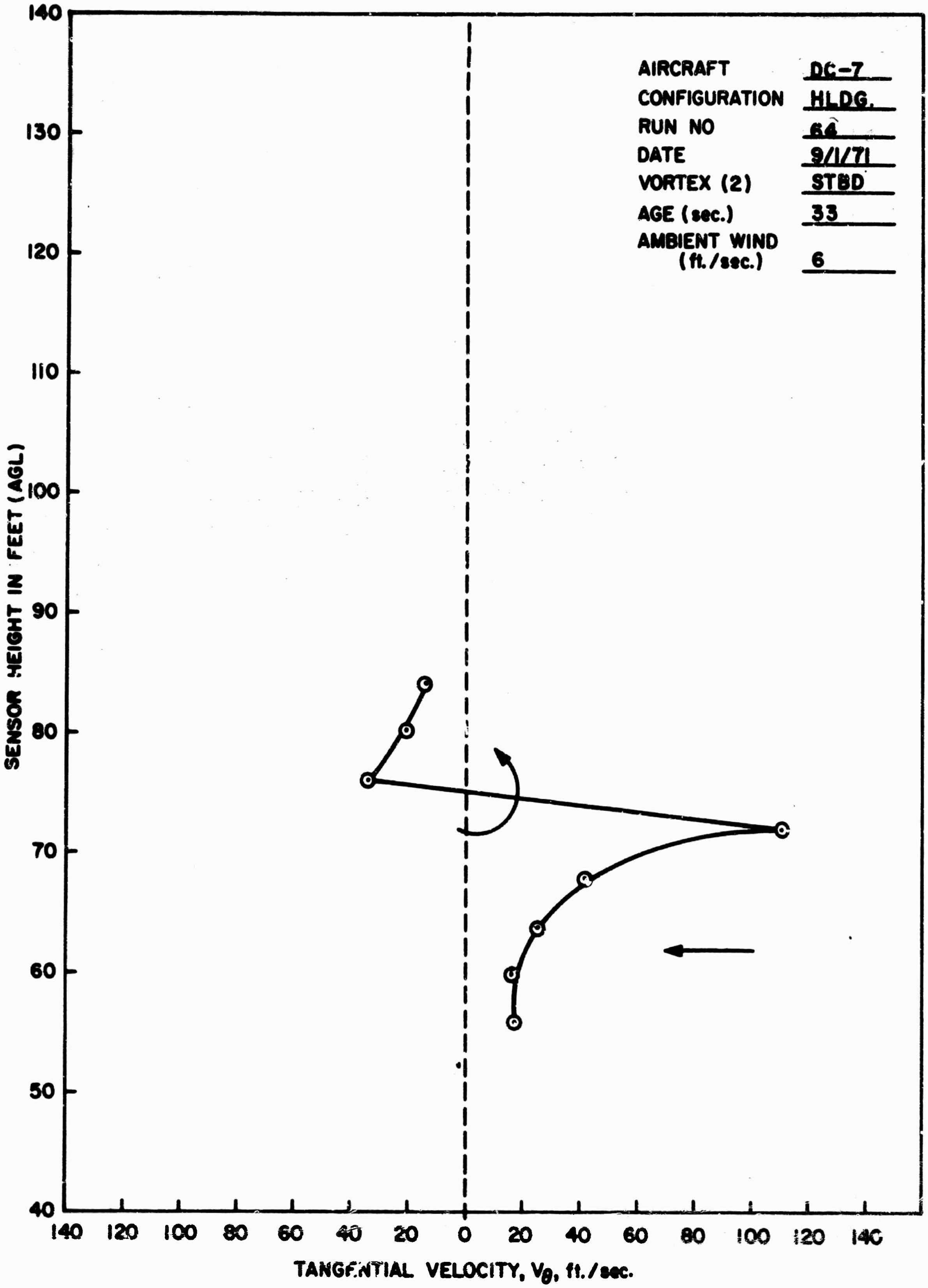
AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN. NO 96
DATE 9/16/71
VORTEX (1) STBD
AGE (sec.) 27
AMBIENT WIND (ft./sec.) 7
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.

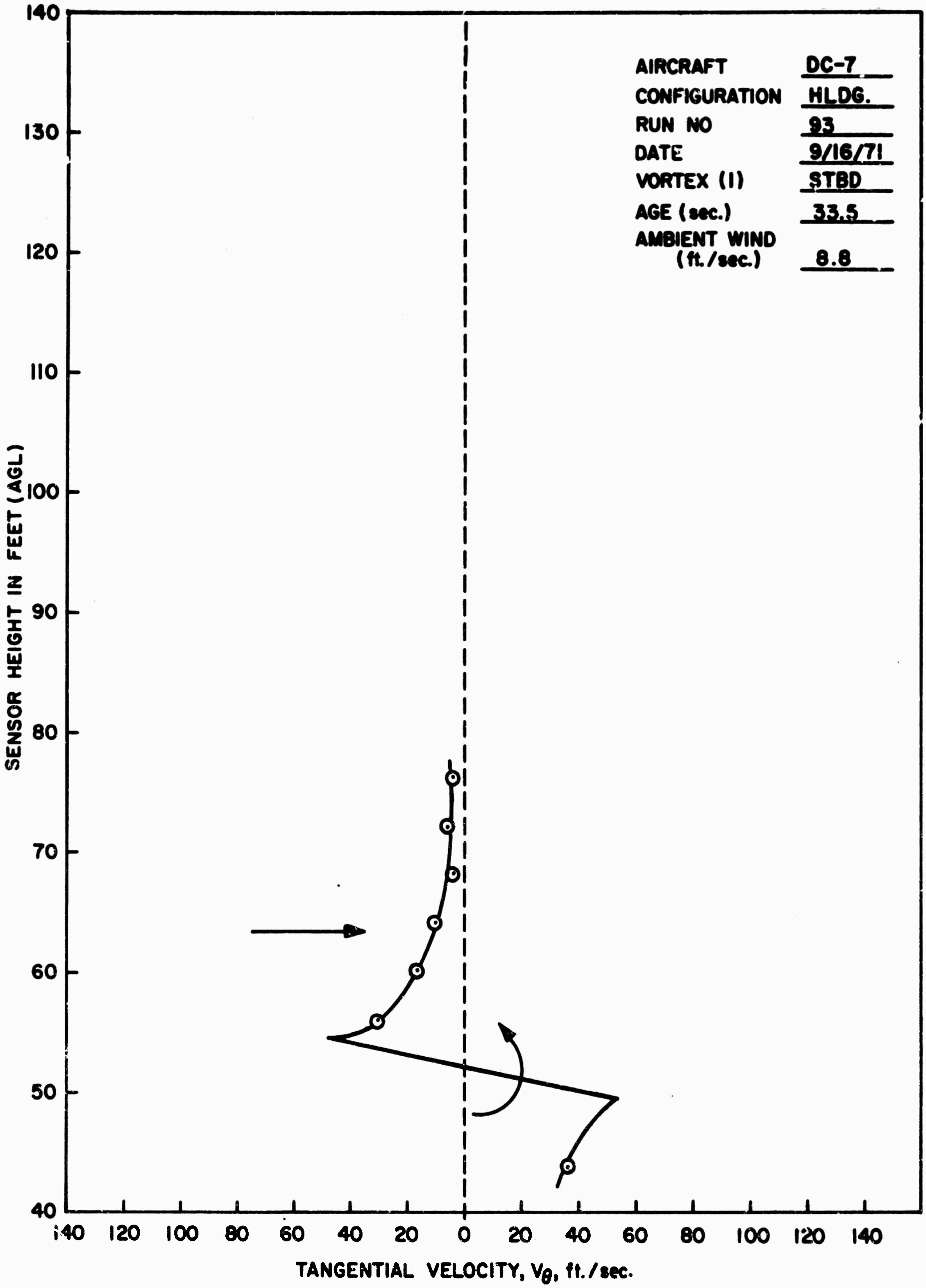


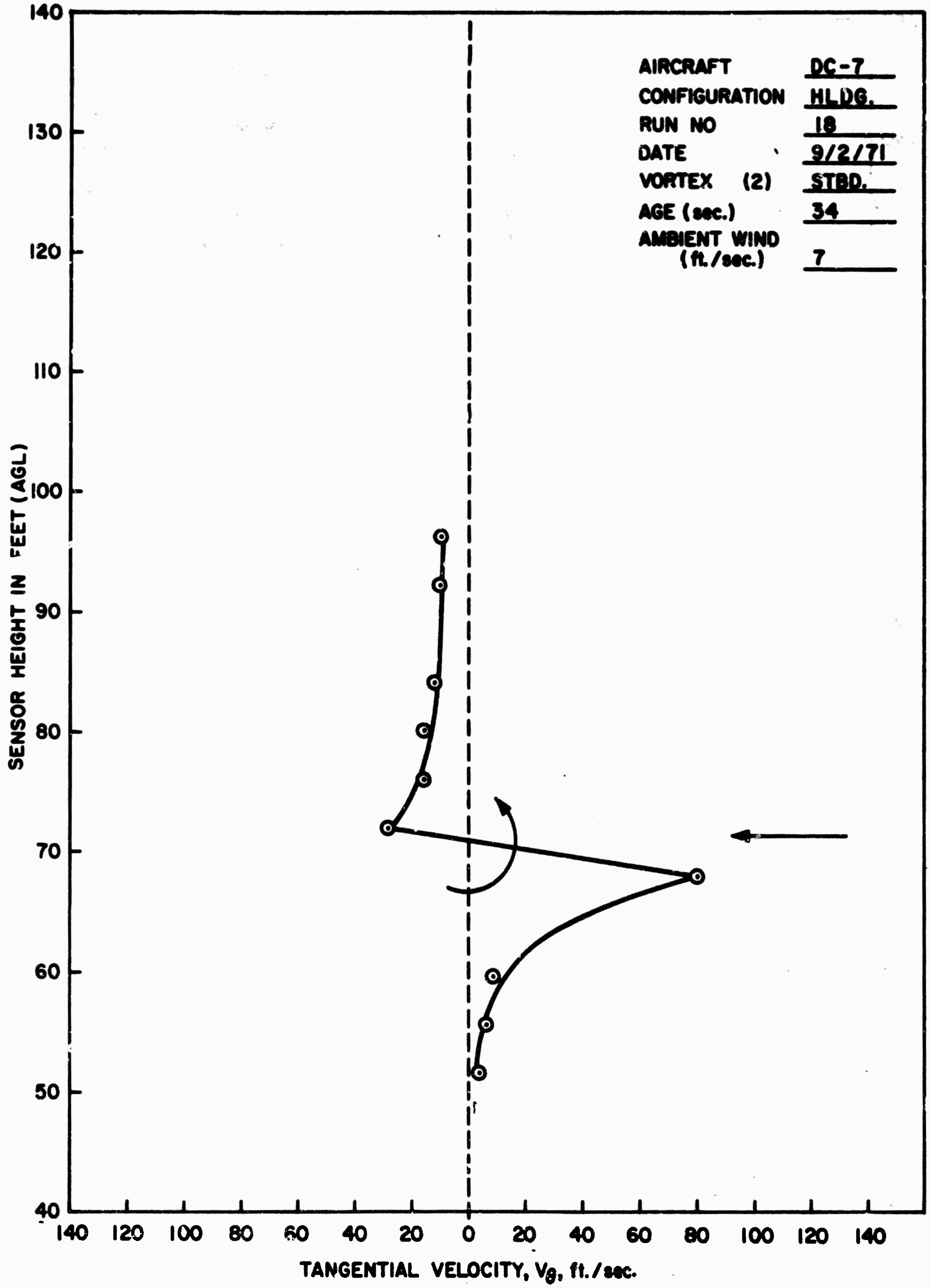
AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN. NO 105
DATE 9/16/71
VORTEX (1) STBD
AGE (sec.) 29
AMBIENT WIND (ft./sec.) 4.3
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
100
90
80
70
60
50
40
30
20
10
0
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

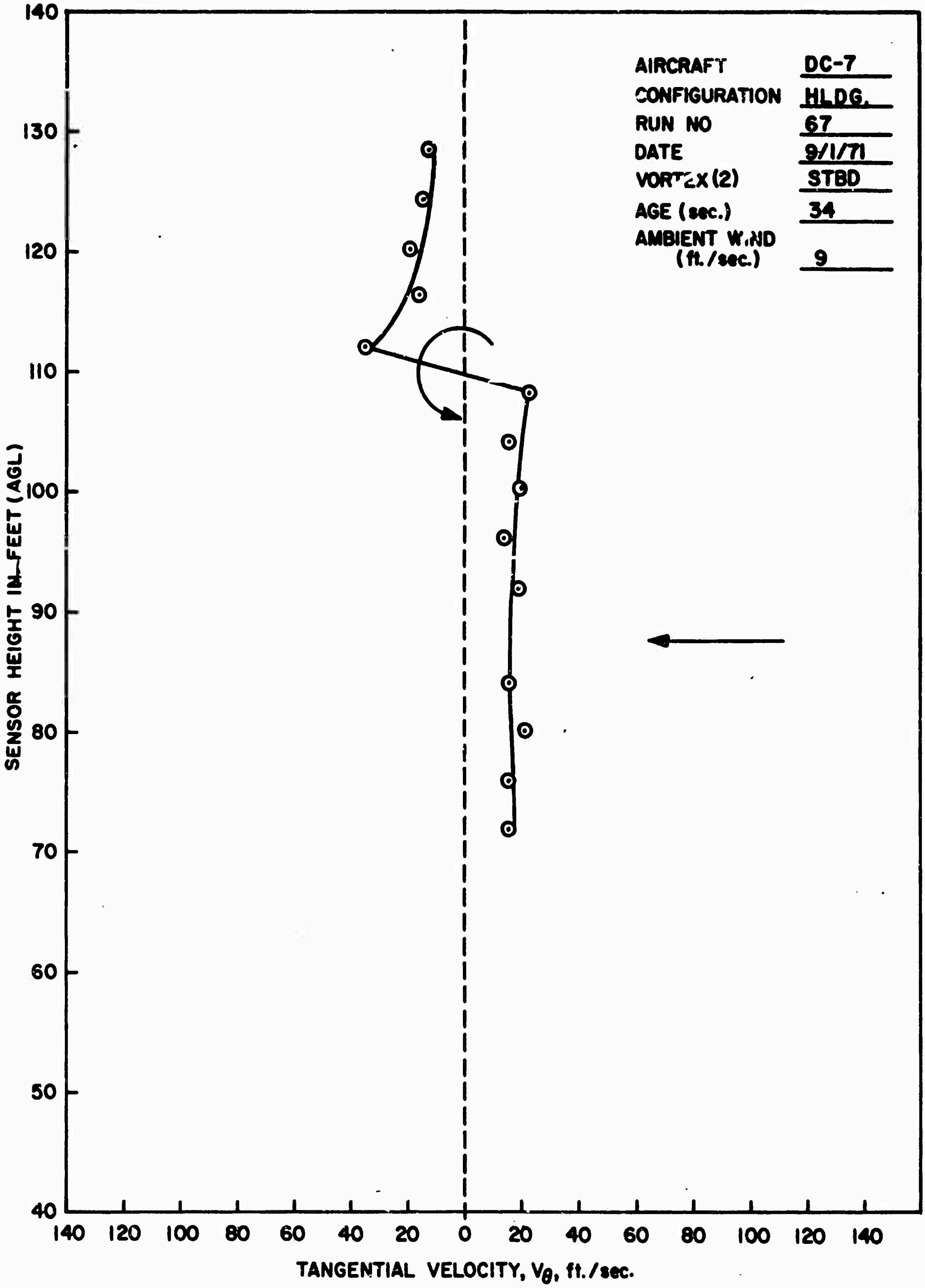


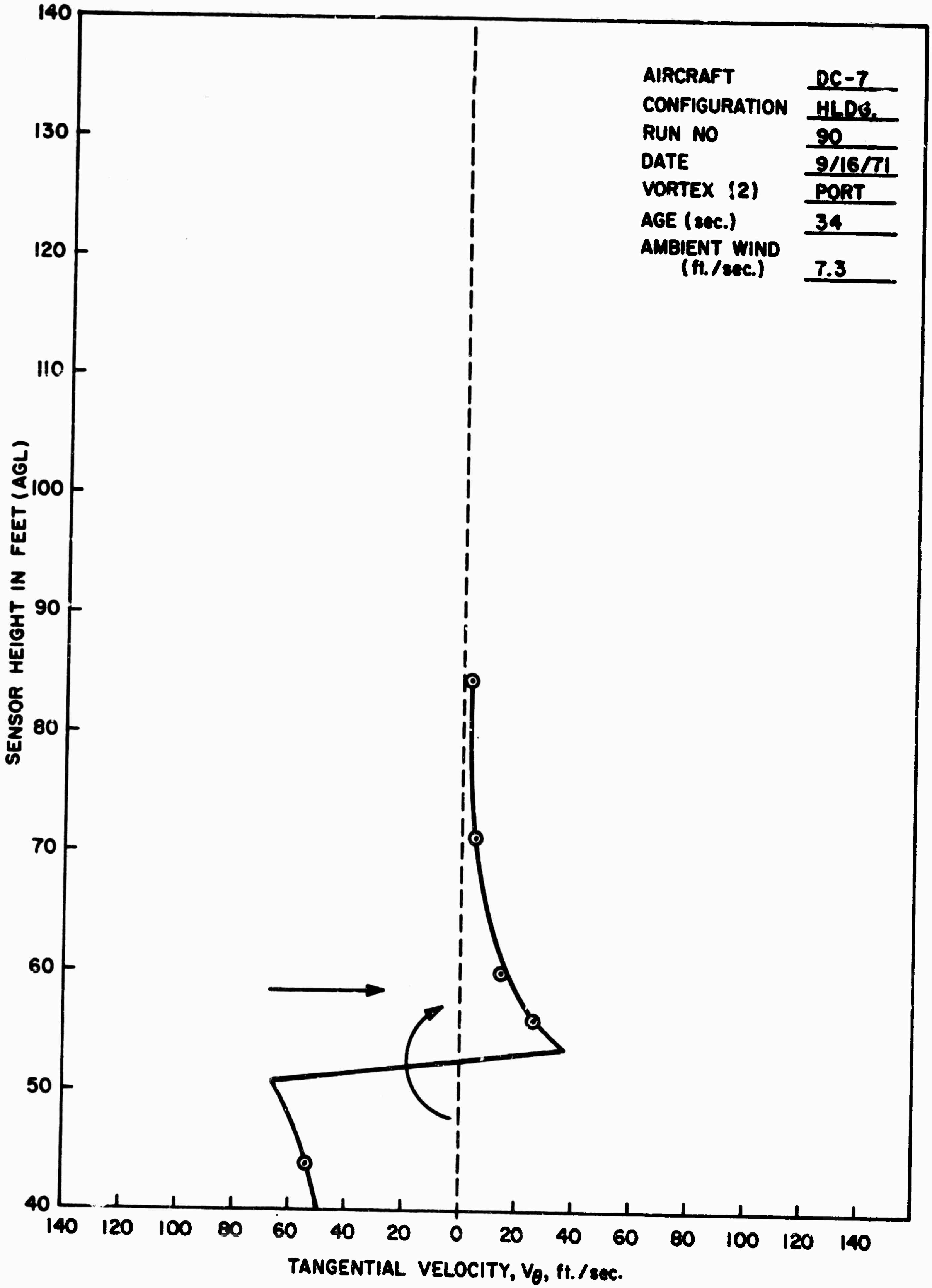
AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 68
DATE 9/1/71
VORTEX (1) PORT
AGE (sec.) 32
AMBIENT WIND (ft./sec.) 10
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

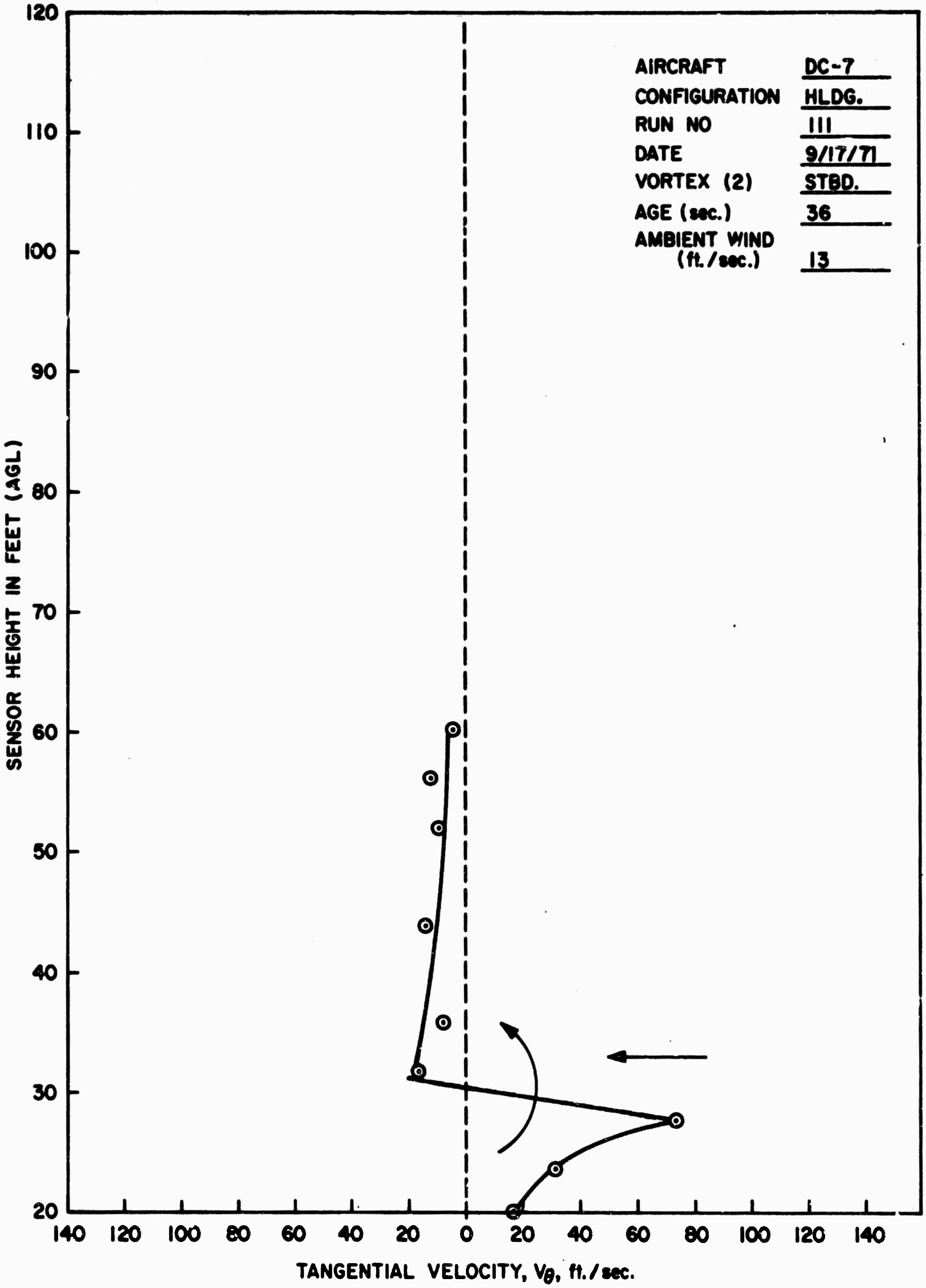

AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 64
DATE 9/1/71
VORTEX (2) STBD
AGE (sec.) 33
AMBIENT WIND (ft./sec.) 6
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.

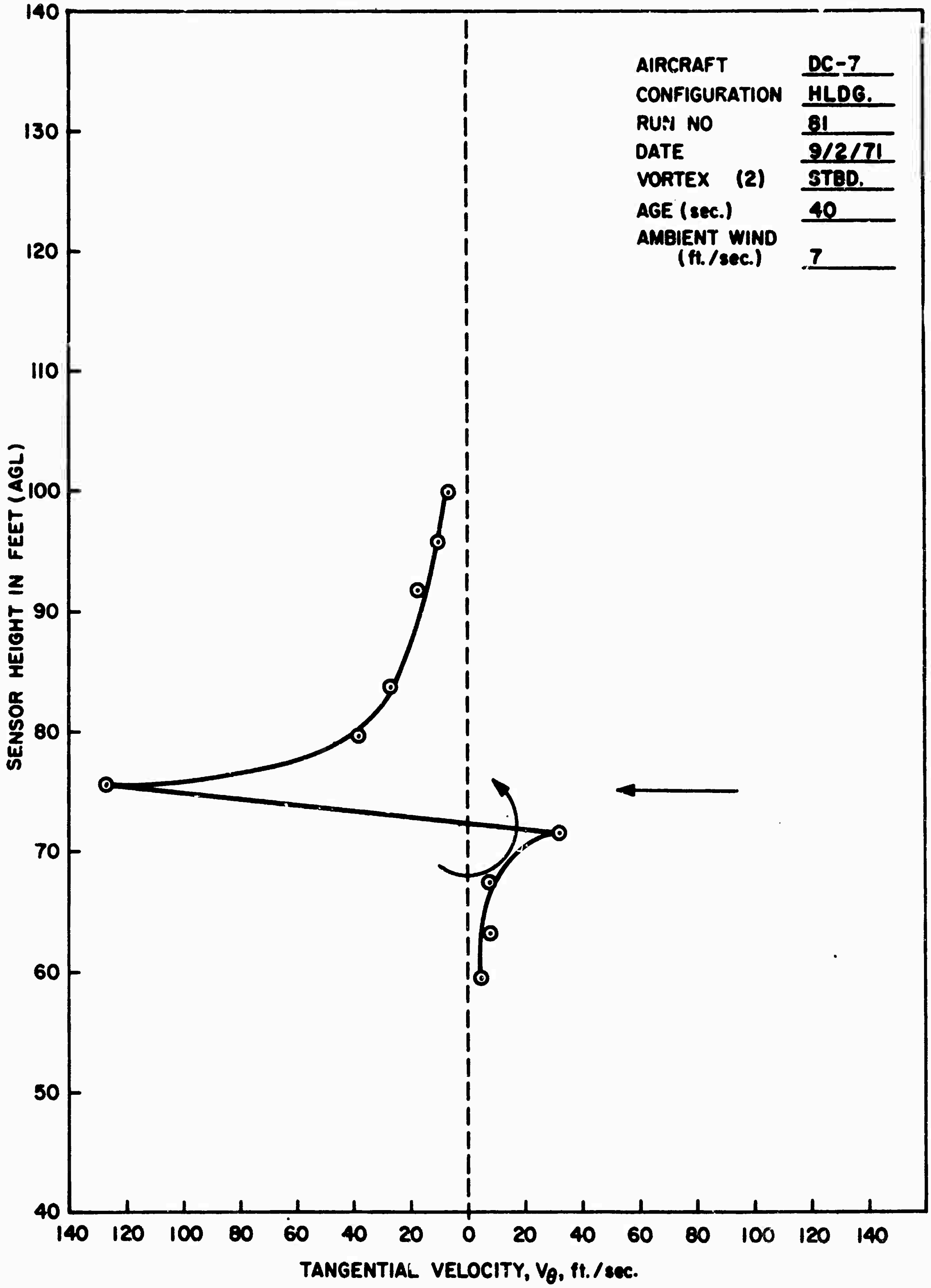

AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 93
DATE 9/16/71
VORTEX (1) STBD
AGE (sec.) 33.5
AMBIENT WIND (ft./sec.) 8.8
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

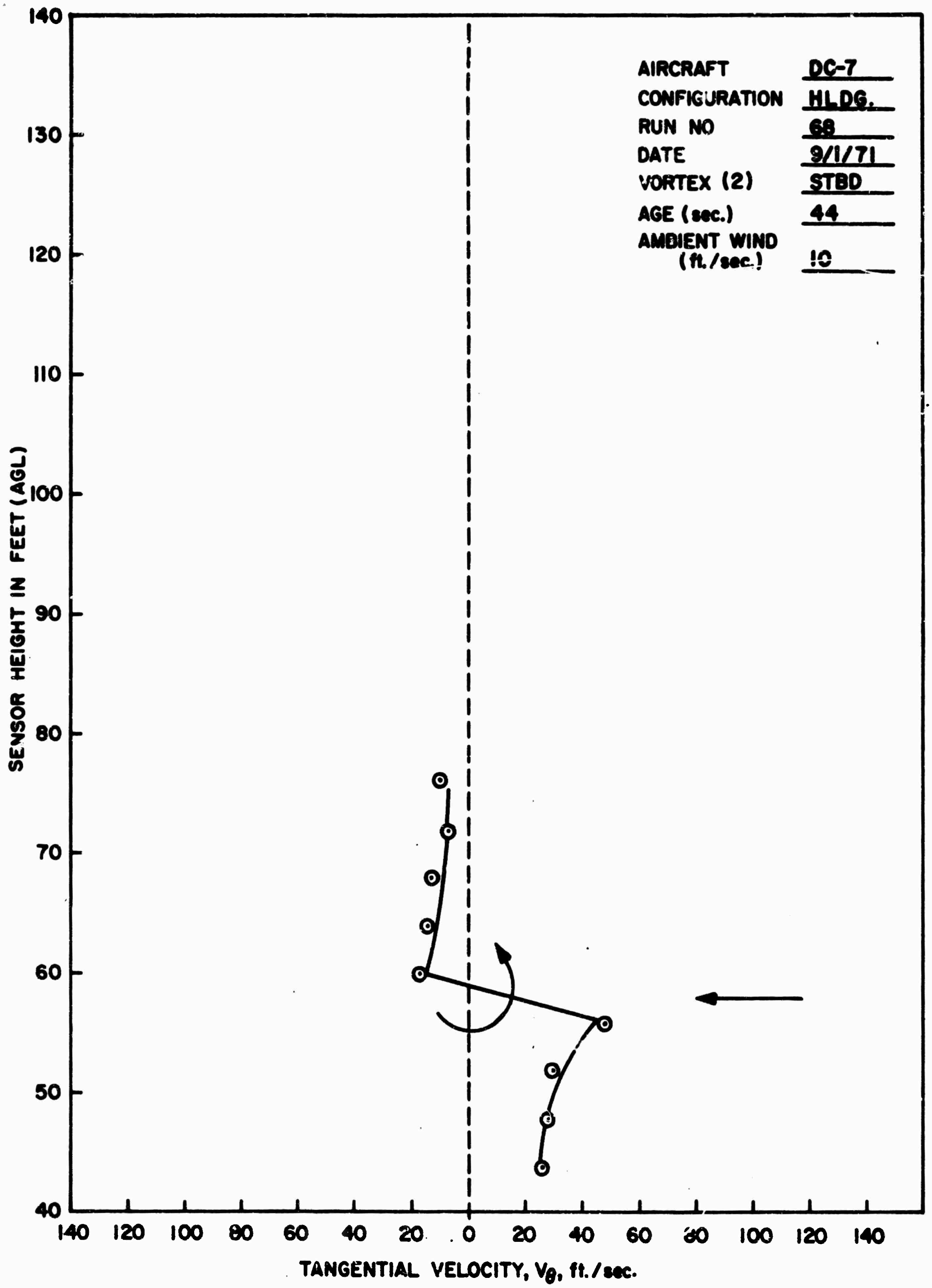

AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 18
DATE 9/2/71
VORTEX (2) STBD.
AGE (sec.) 34
AMBIENT WIND (ft./sec.) 7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

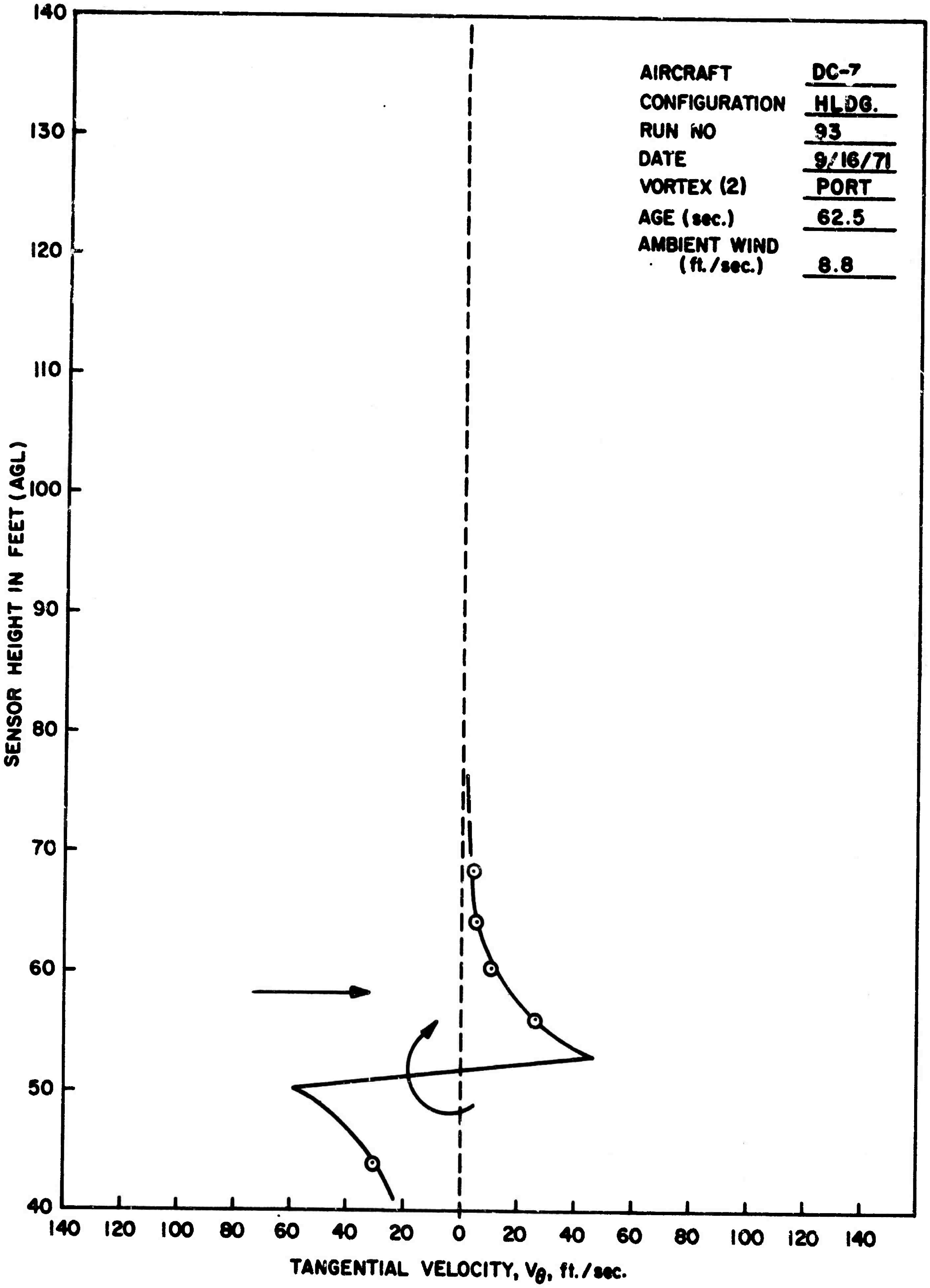

AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 67
DATE 9/1/71
VORTEX (2) STBD
AGE (sec.) 34
AMBIENT WIND (ft./sec.) 9
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140


AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 90
DATE 9/16/71
VORTEX (2) PORT
AGE (sec.) 34
AMBIENT WIND (ft./sec.) 7.3
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

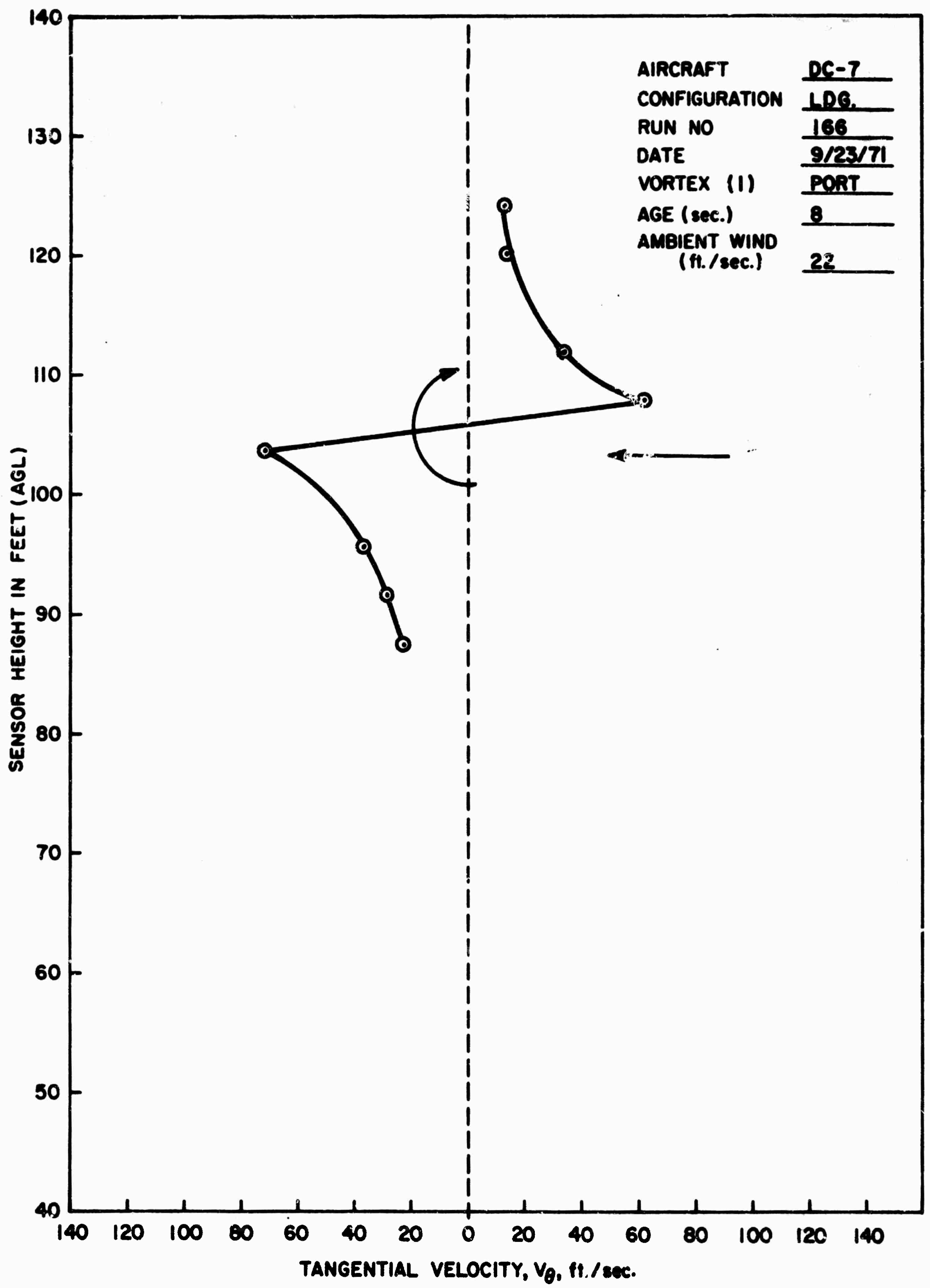

AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 111
DATE 9/17/71
VORTEX (2) STBD.
AGE (sec.) 36
AMBIENT WIND (ft./sec.) 13
SENSOR HEIGHT IN FEET (AGL)
120
110
100
90
80
70
60
50
40
30
20
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 81
DATE 9/2/71
VORTEX (2) STBD.
AGE (sec.) 40
AMBIENT WIND (ft./sec.) 7
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

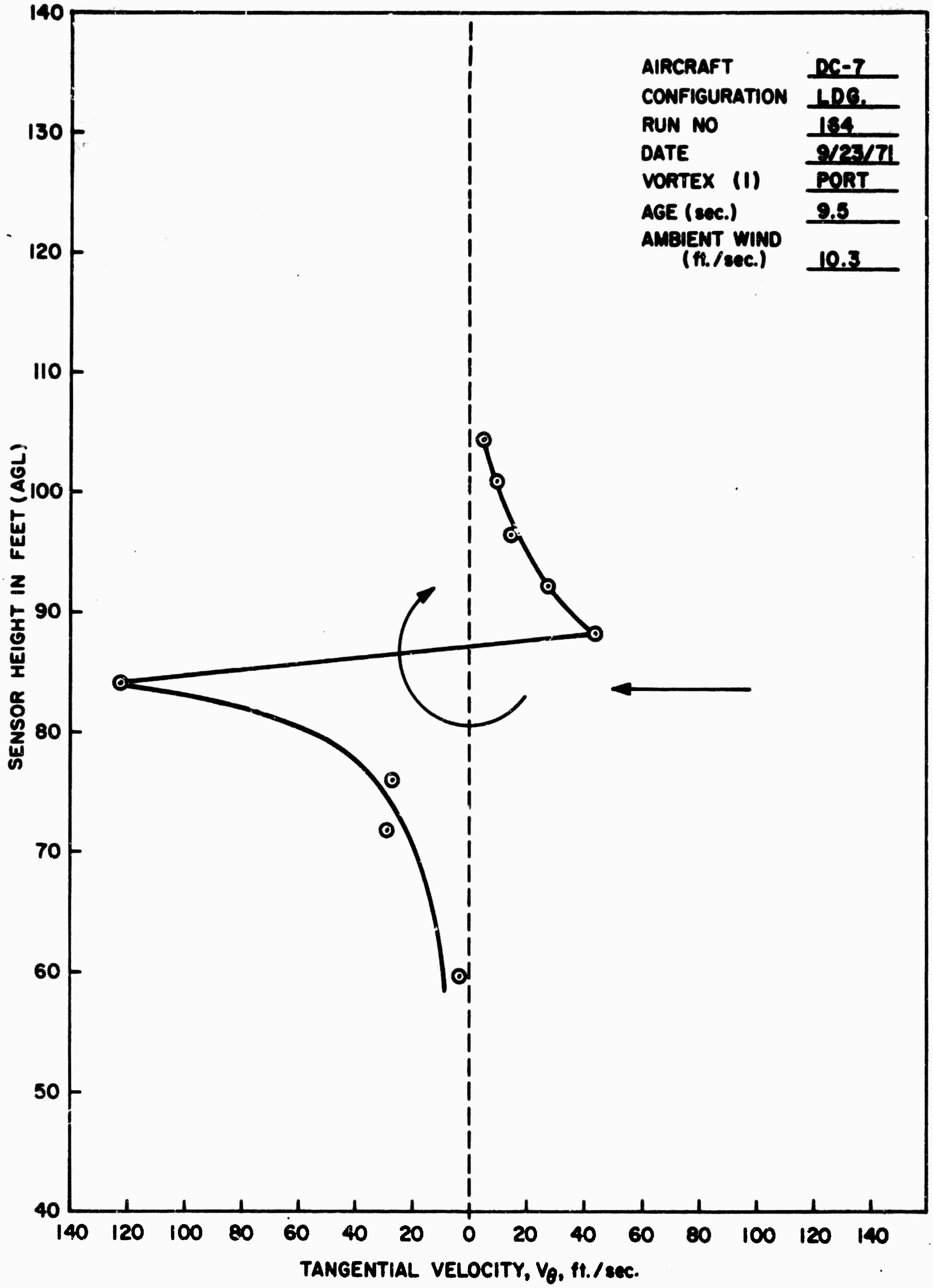

AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 68
DATE 9/1/71
VORTEX (2) STBD
AGE (sec.) 44
AMBIENT WIND (ft./sec.) 10
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



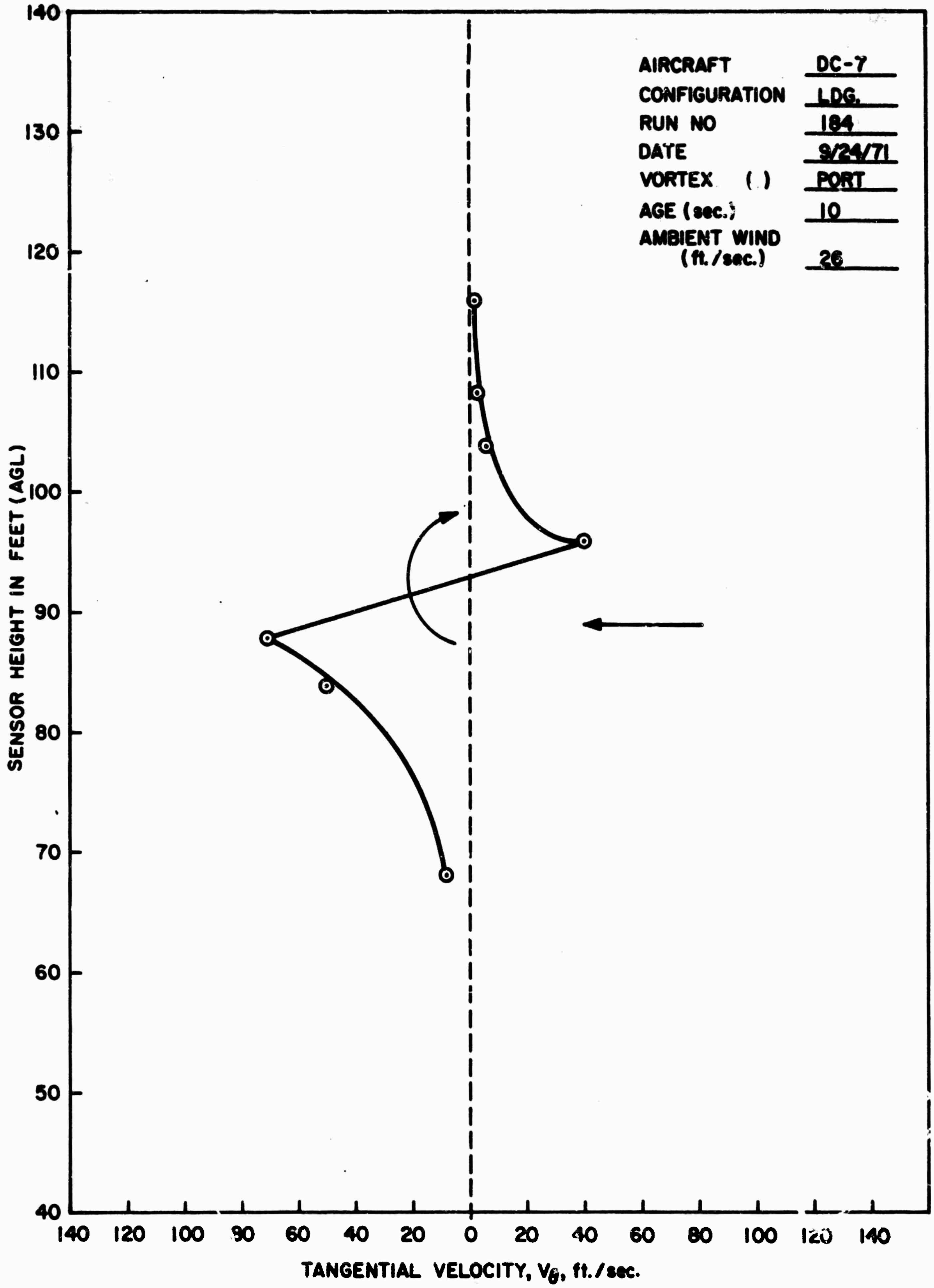
AIRCRAFT DC-7
CONFIGURATION HLDG.
RUN NO 93
DATE 9/16/71
VORTEX (2) PORT
AGE (sec.) 62.5
AMBIENT WIND (ft./sec.) 8.8
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



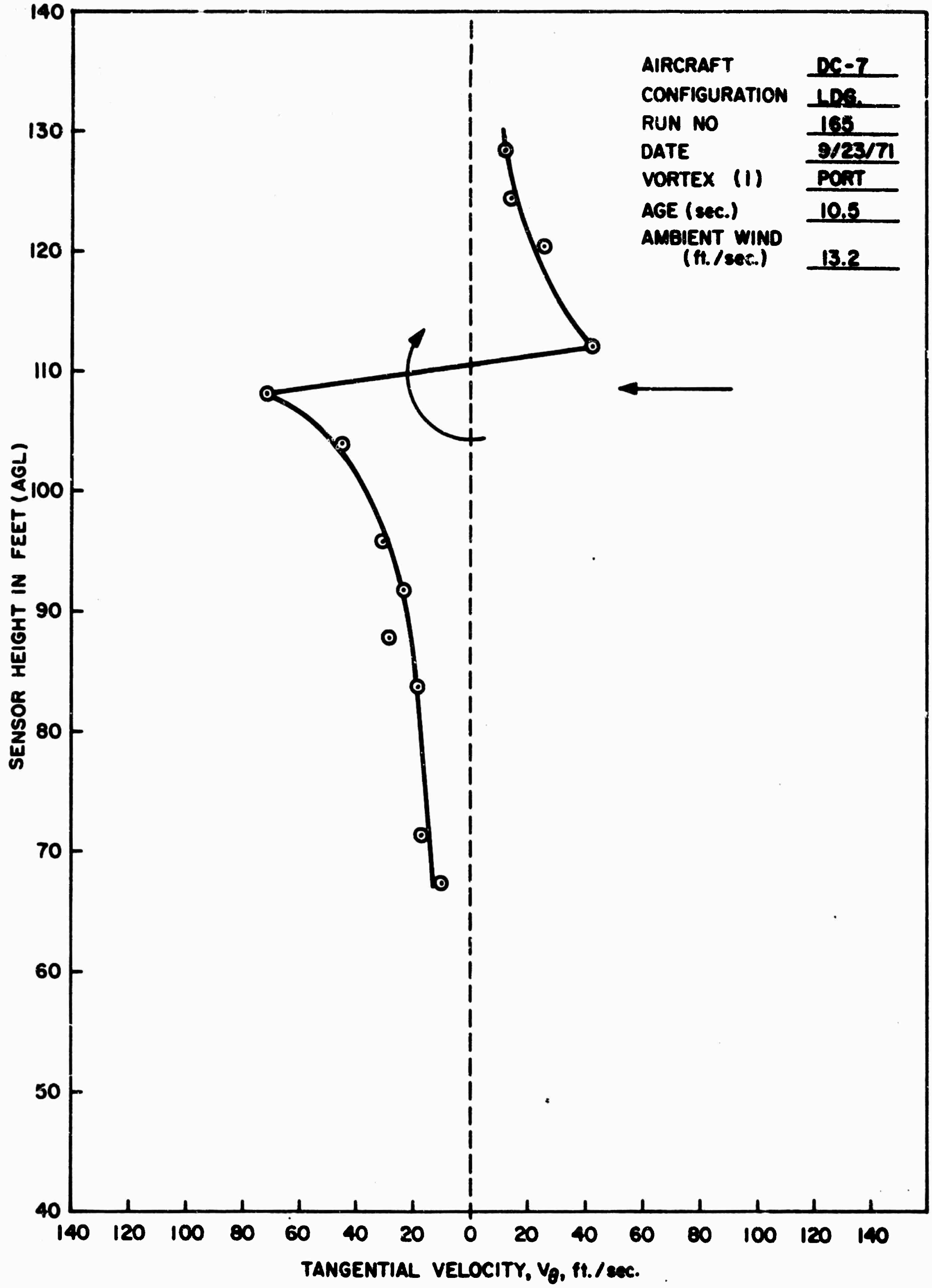
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 166
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 8
AMBIENT WIND (ft./sec.) 22
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

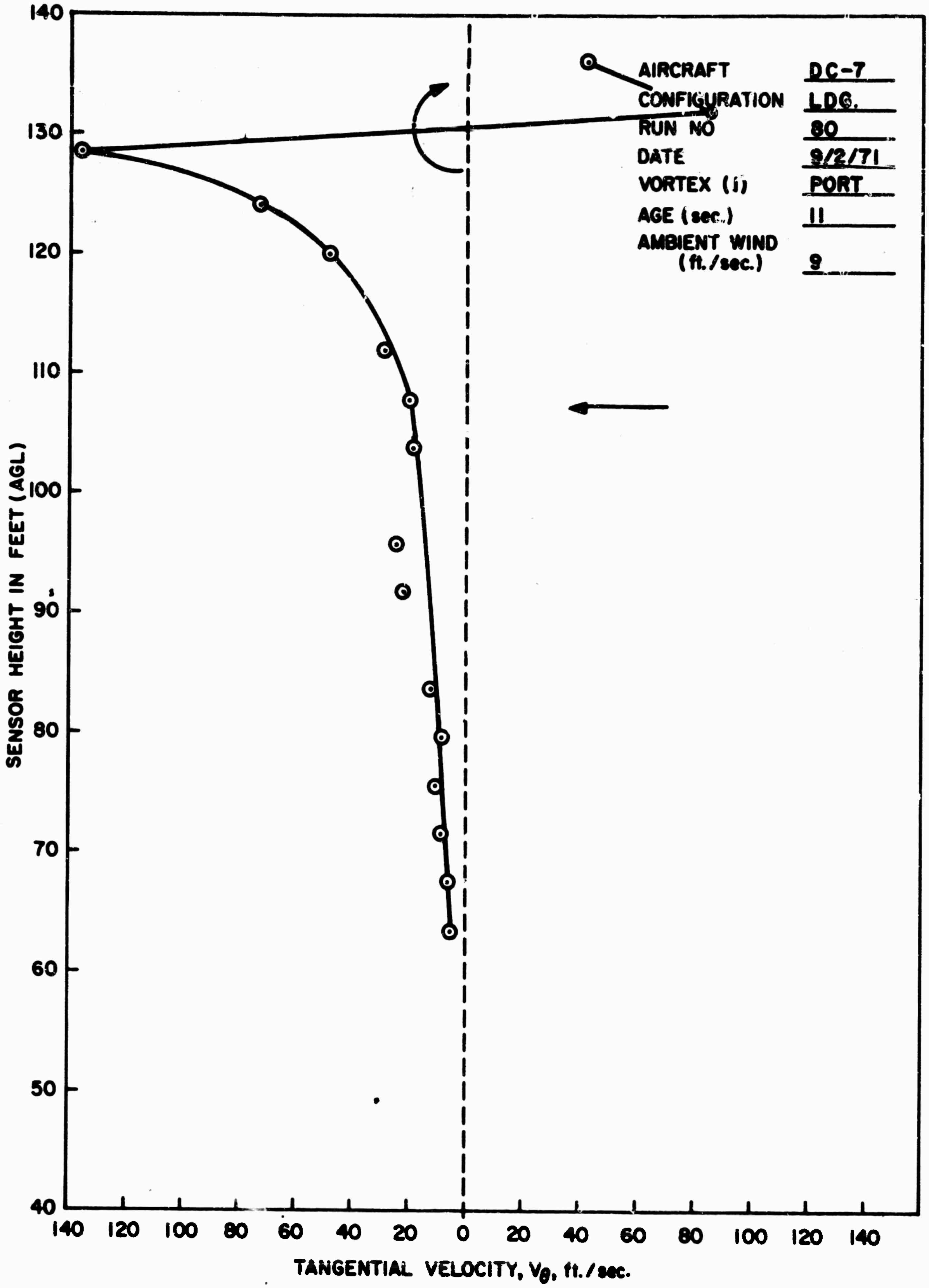


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 184
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 9.5
AMBIENT WIND (ft./sec.) 10.3
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

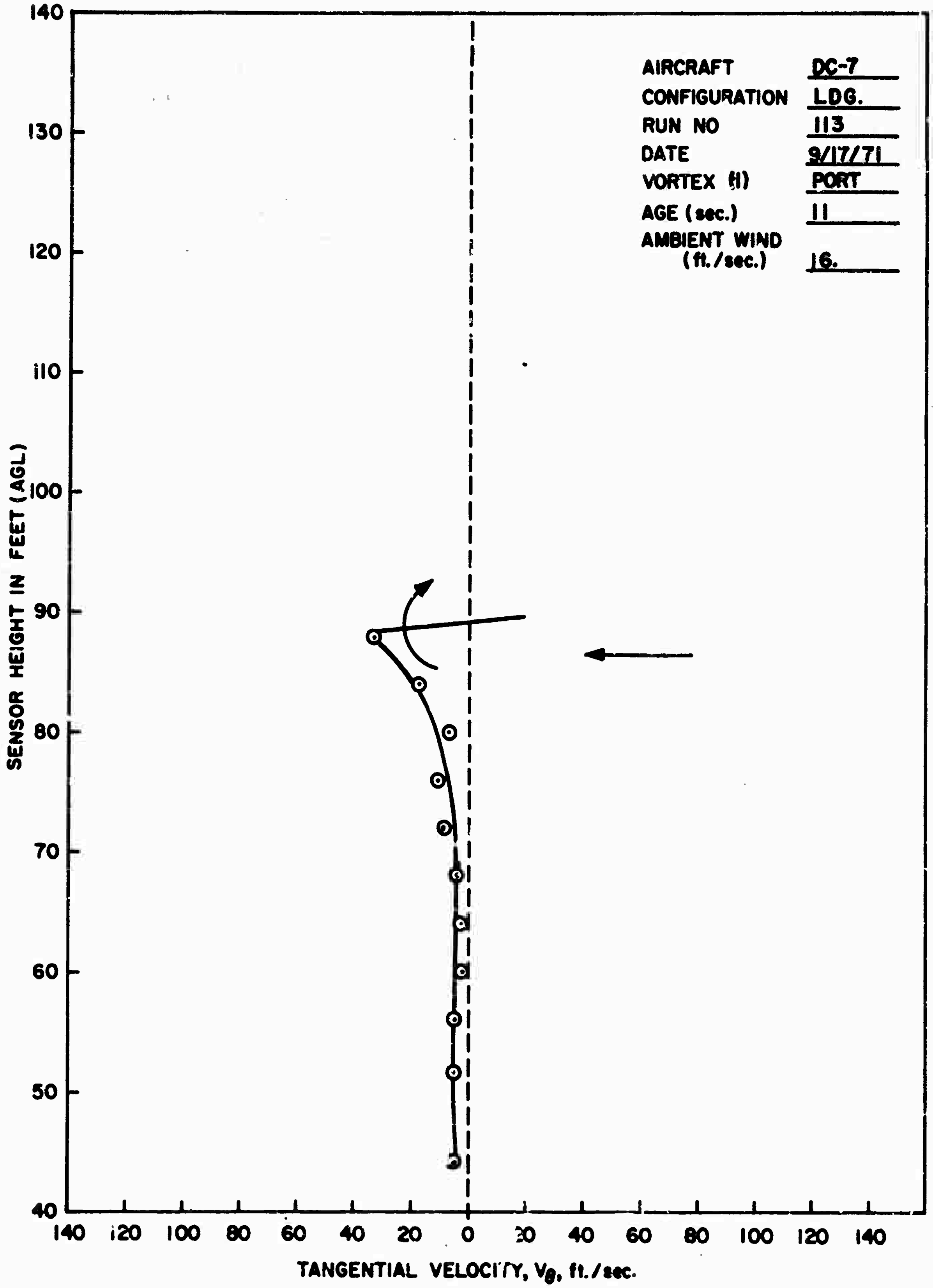


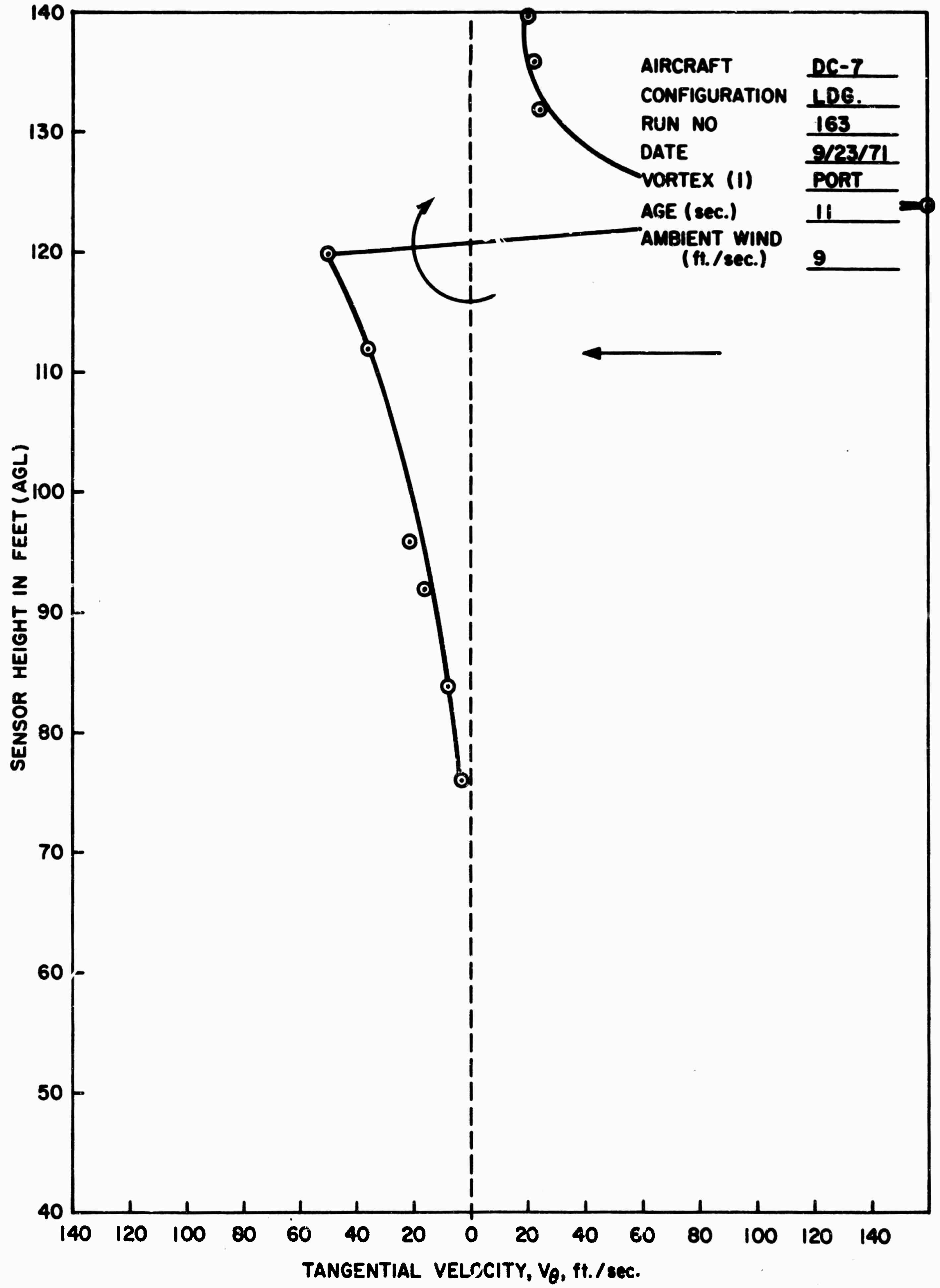
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 184
DATE 9/24/71
VORTEX ( ) PORT
AGE (sec.) 10
AMBIENT WIND (ft./sec.) 26
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 165
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 10.5
AMBIENT WIND (ft./sec.) 13.2
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

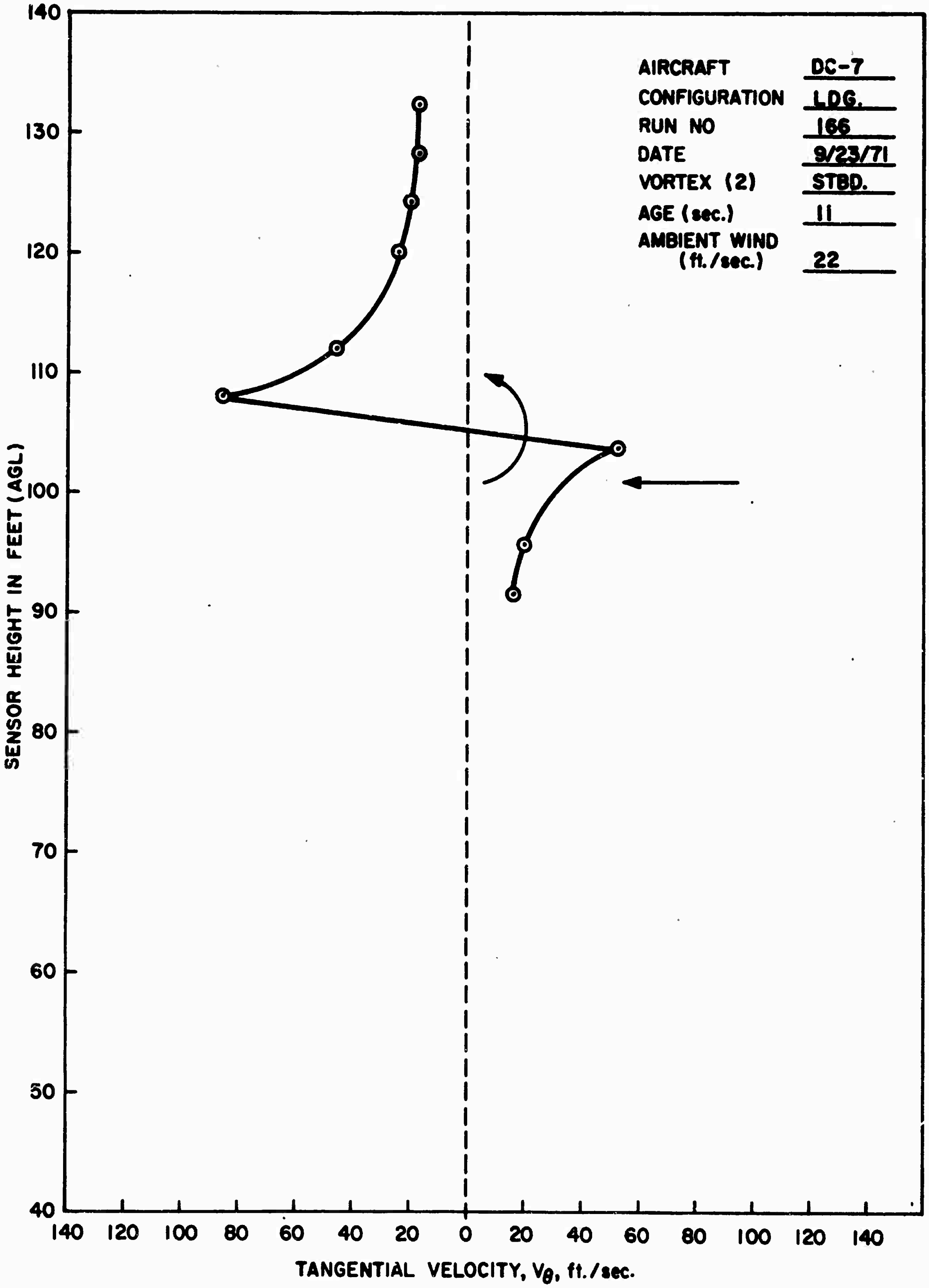


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 80
DATE 9/2/71
VORTEX (i) PORT
AGE (sec.) 11
AMBIENT WIND (ft./sec.) 9
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

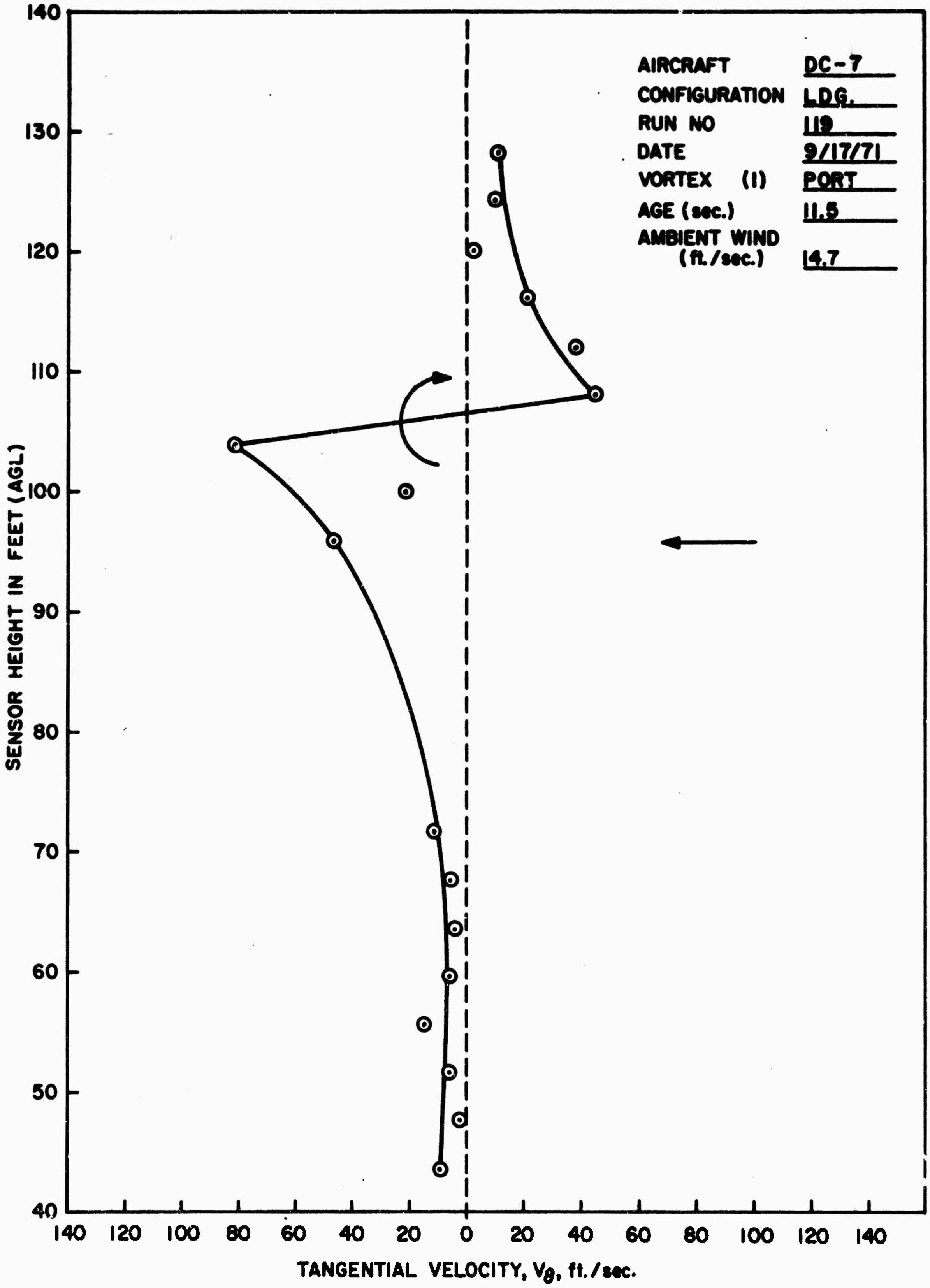

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 113
DATE 9/17/71
VORTEX (H) PORT
AGE (sec.) 11
AMBIENT WIND (ft./sec.) 16.
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



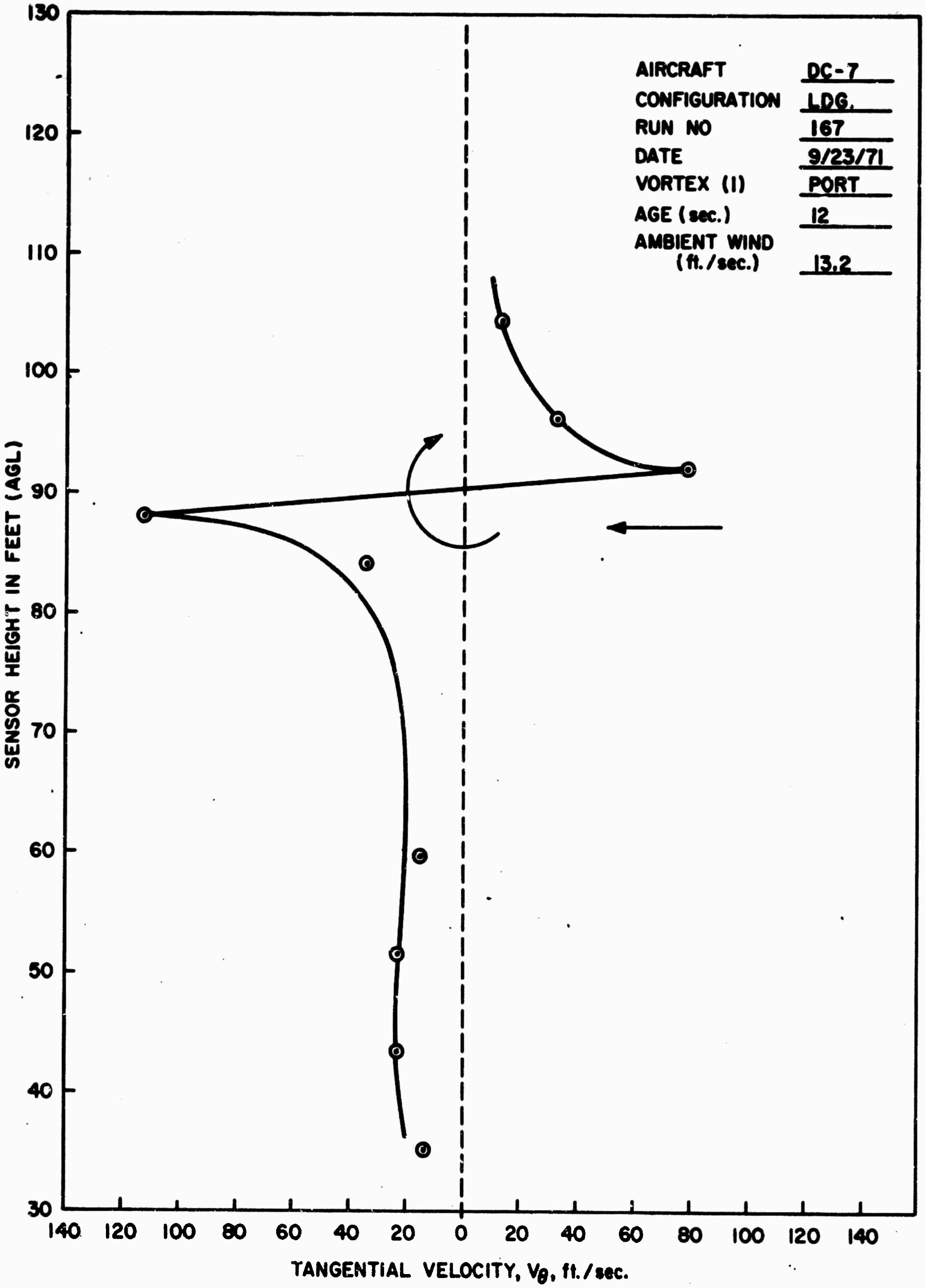
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 163
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 11
AMBIENT WIND (ft./sec.) 9
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



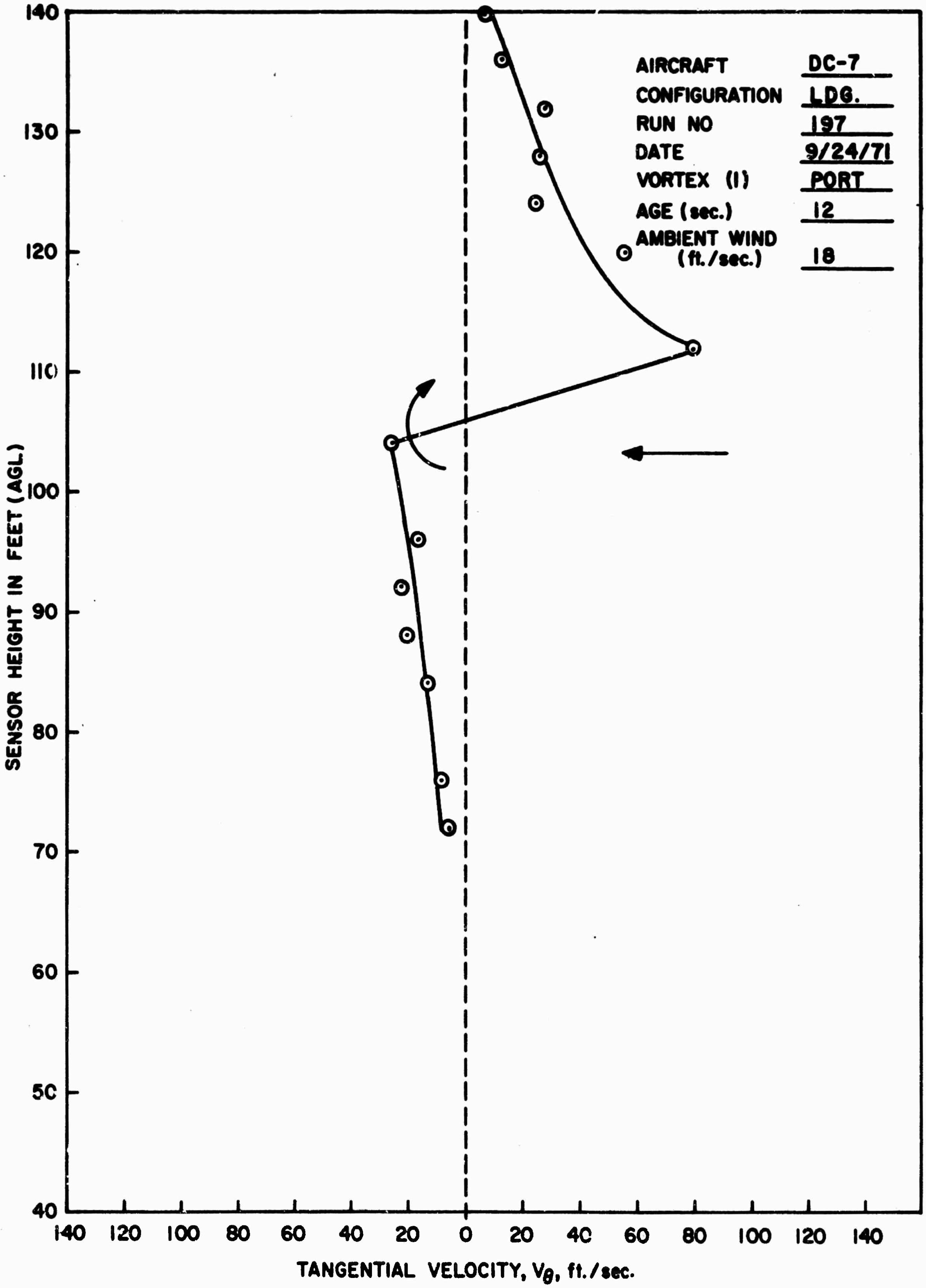
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 166
DATE 9/23/71
VORTEX (2) STBD.
AGE (sec.) 11
AMBIENT WIND (ft./sec.) 22
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



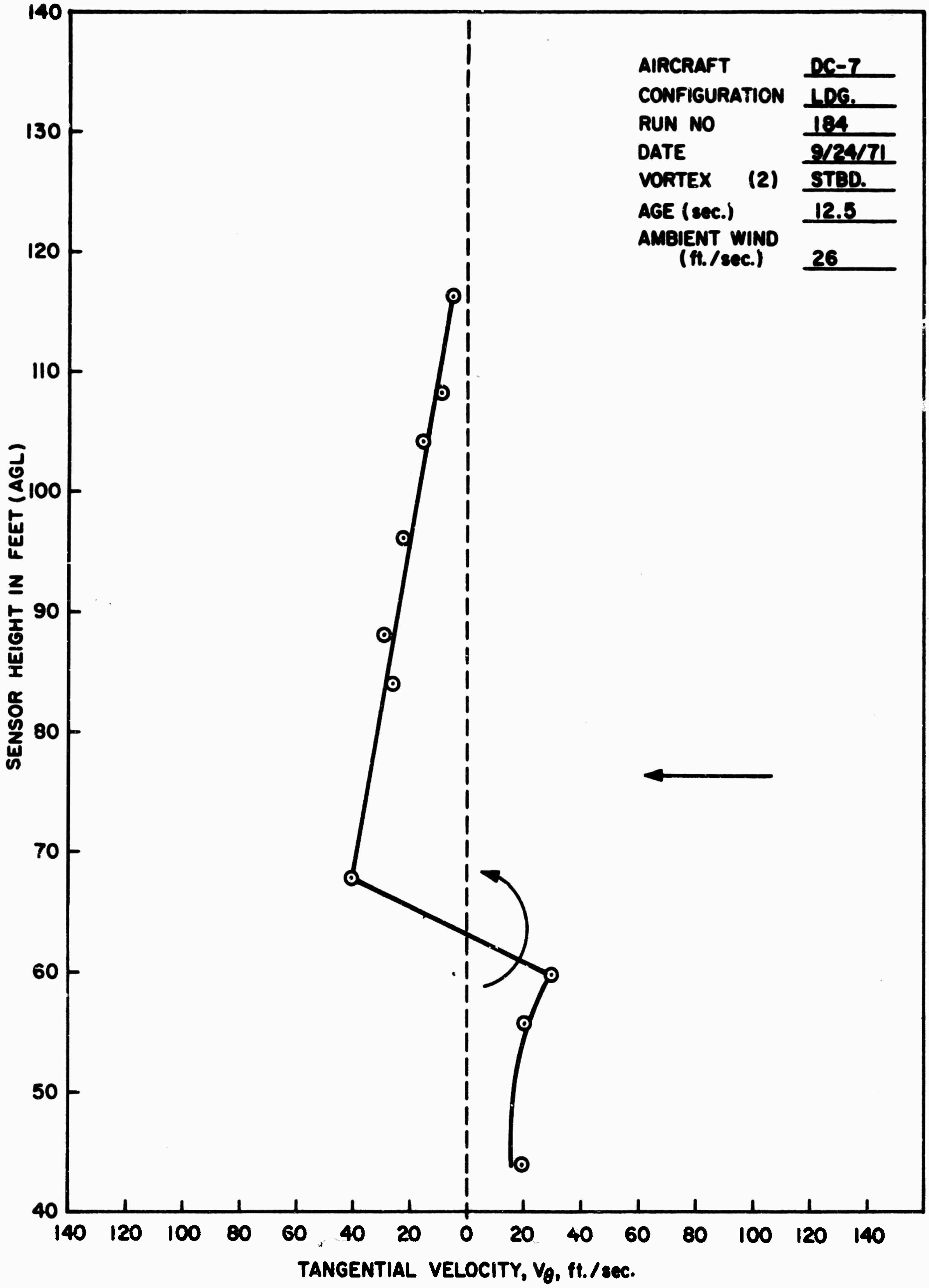
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 119
DATE 9/17/71
VORTEX (1) PORT
AGE (sec.) 11.5
AMBIENT WIND (ft./sec.) 14.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



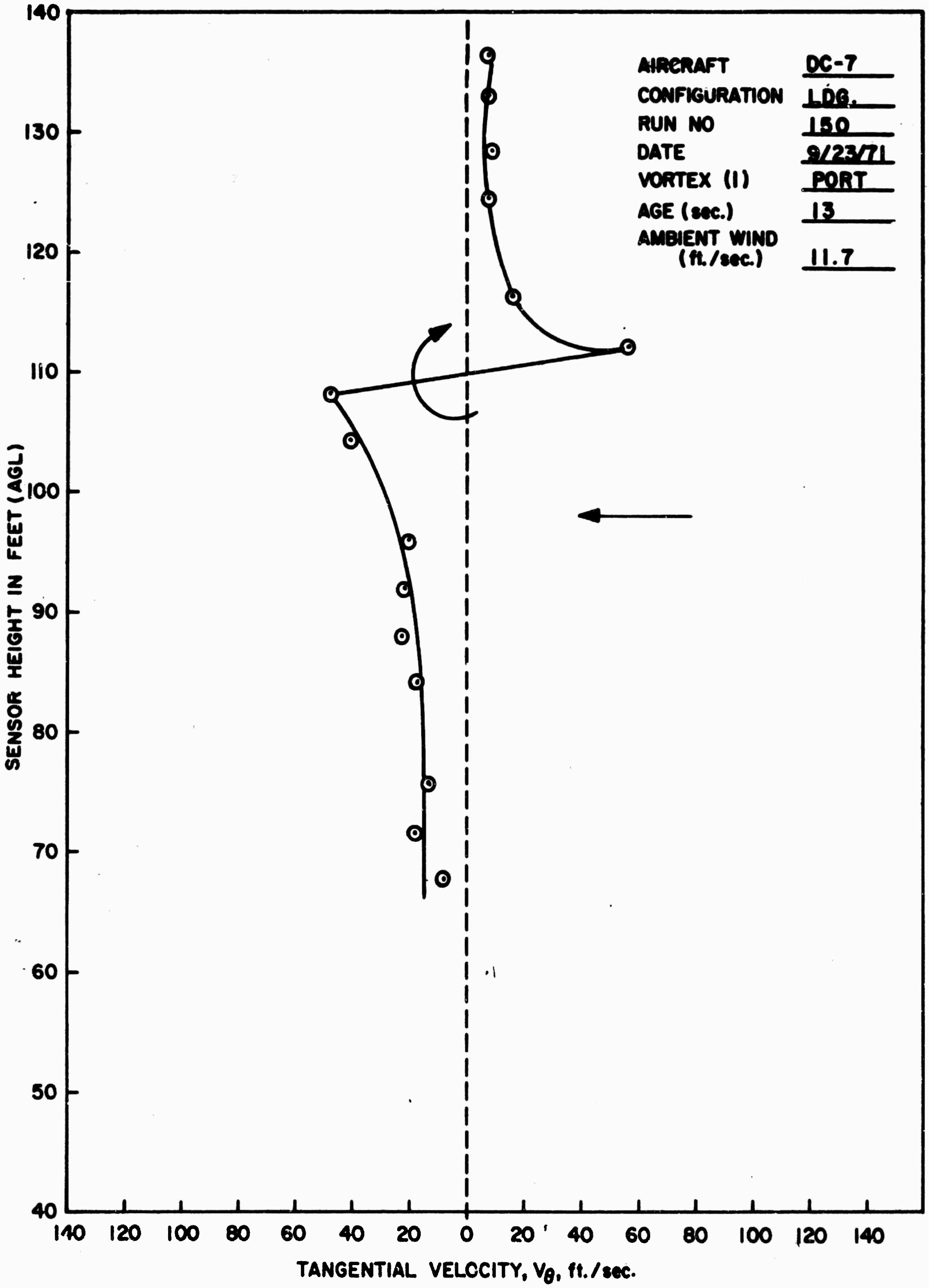
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 167
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 12
AMBIENT WIND (ft./sec.) 13.2
SENSOR HEIGHT IN FEET (AGL)
130
120
110
100
90
80
70
60
50
40
30
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

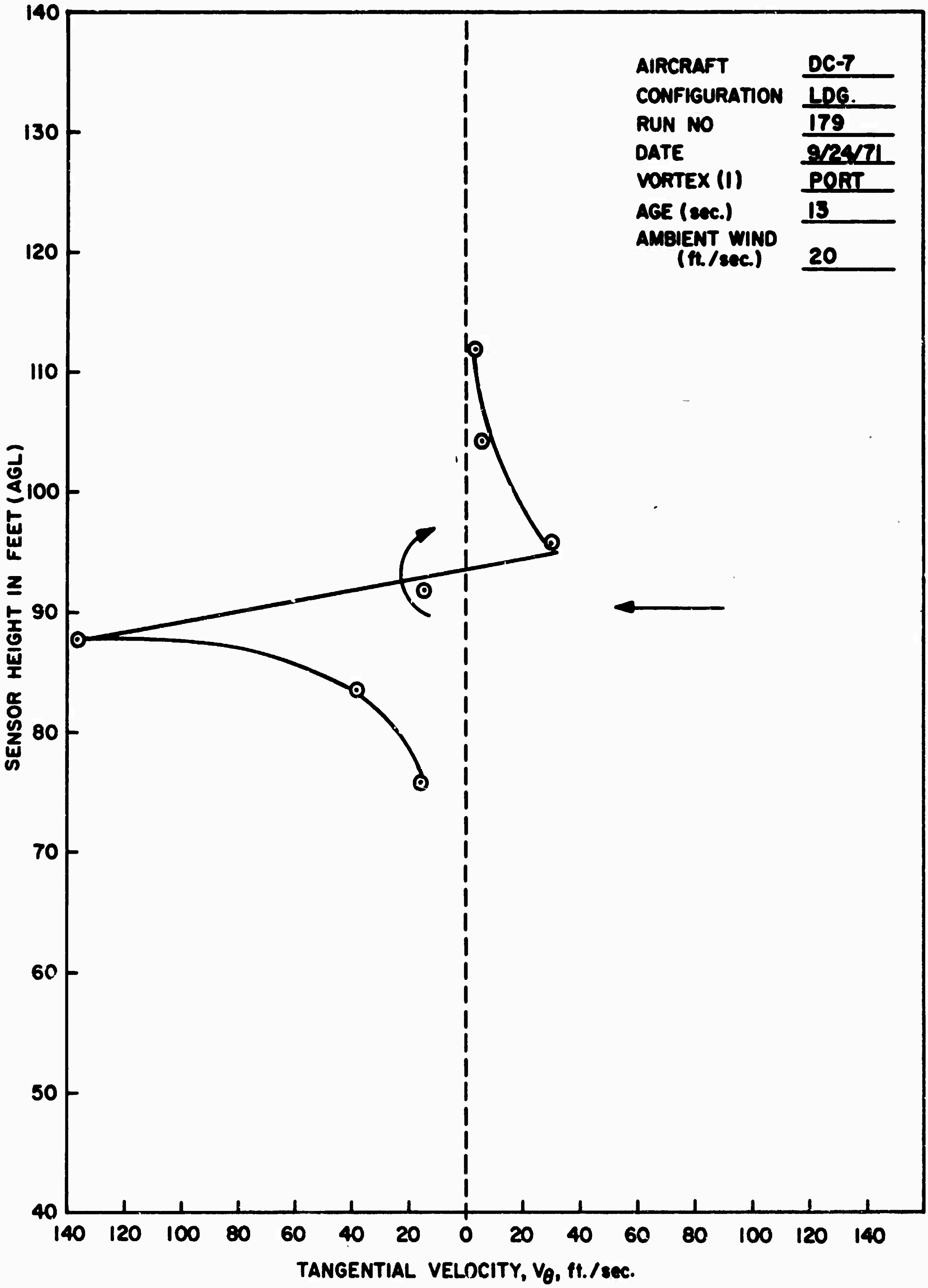


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 197
DATE 9/24/71
VORTEX (1) PORT
AGE (sec.) 12
AMBIENT WIND (ft./sec.) 18
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

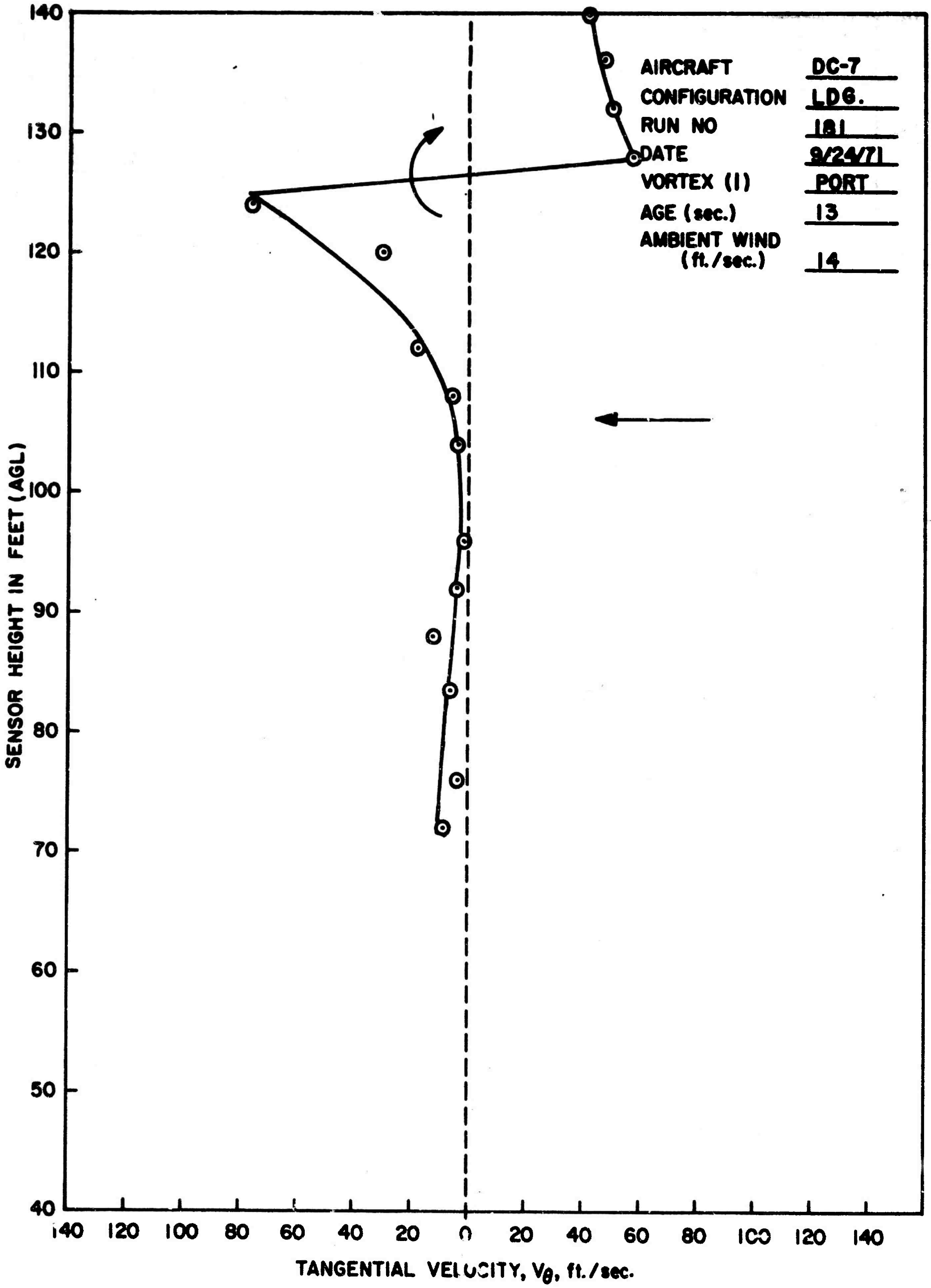


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 184
DATE 9/24/71
VORTEX (2) STBD.
AGE (sec.) 12.5
AMBIENT WIND (ft./sec.) 26
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

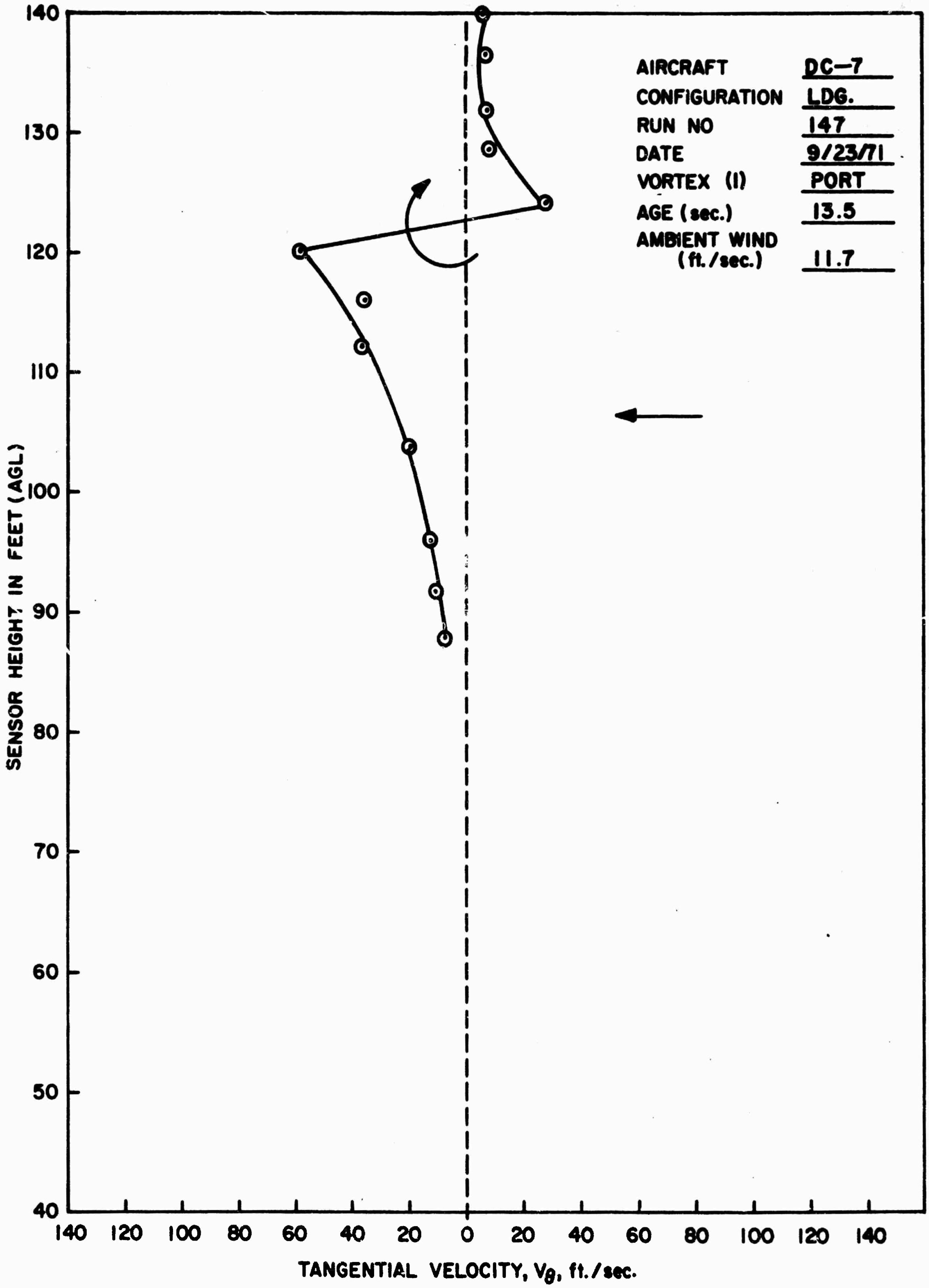

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 150
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 13
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



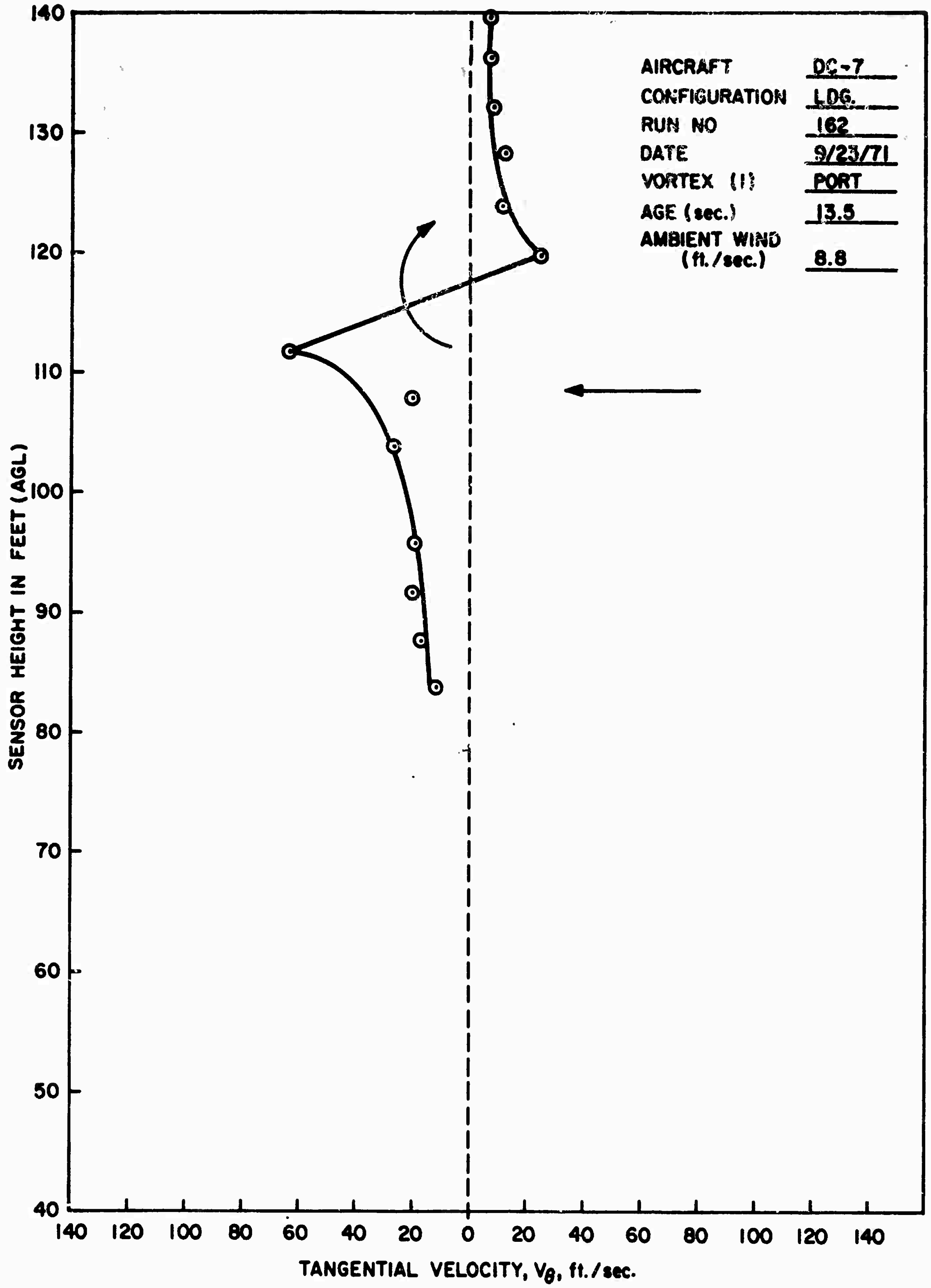
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 179
DATE 9/24/71
VORTEX (1) PORT
AGE (sec.) 13
AMBIENT WIND (ft./sec.) 20
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

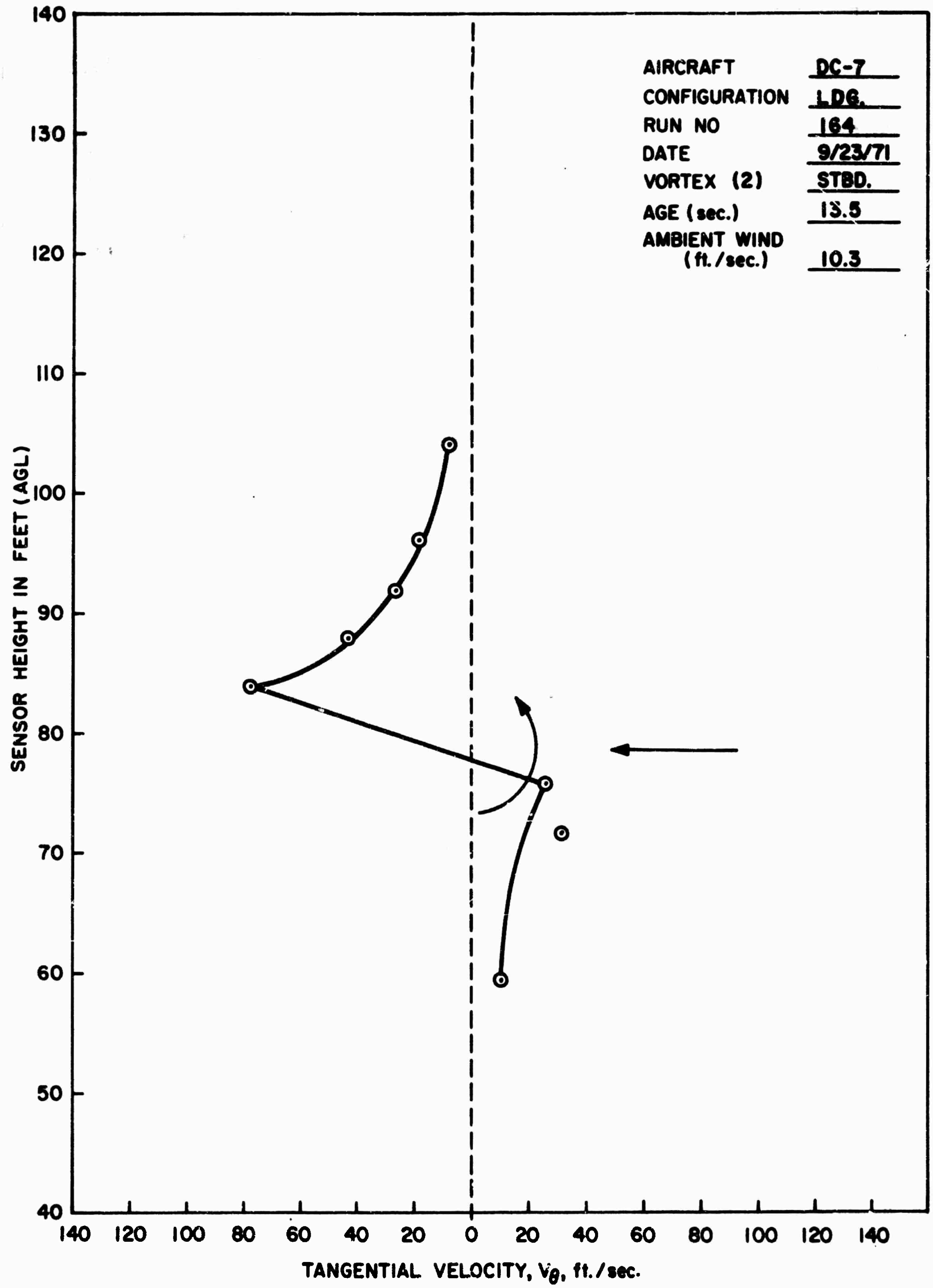


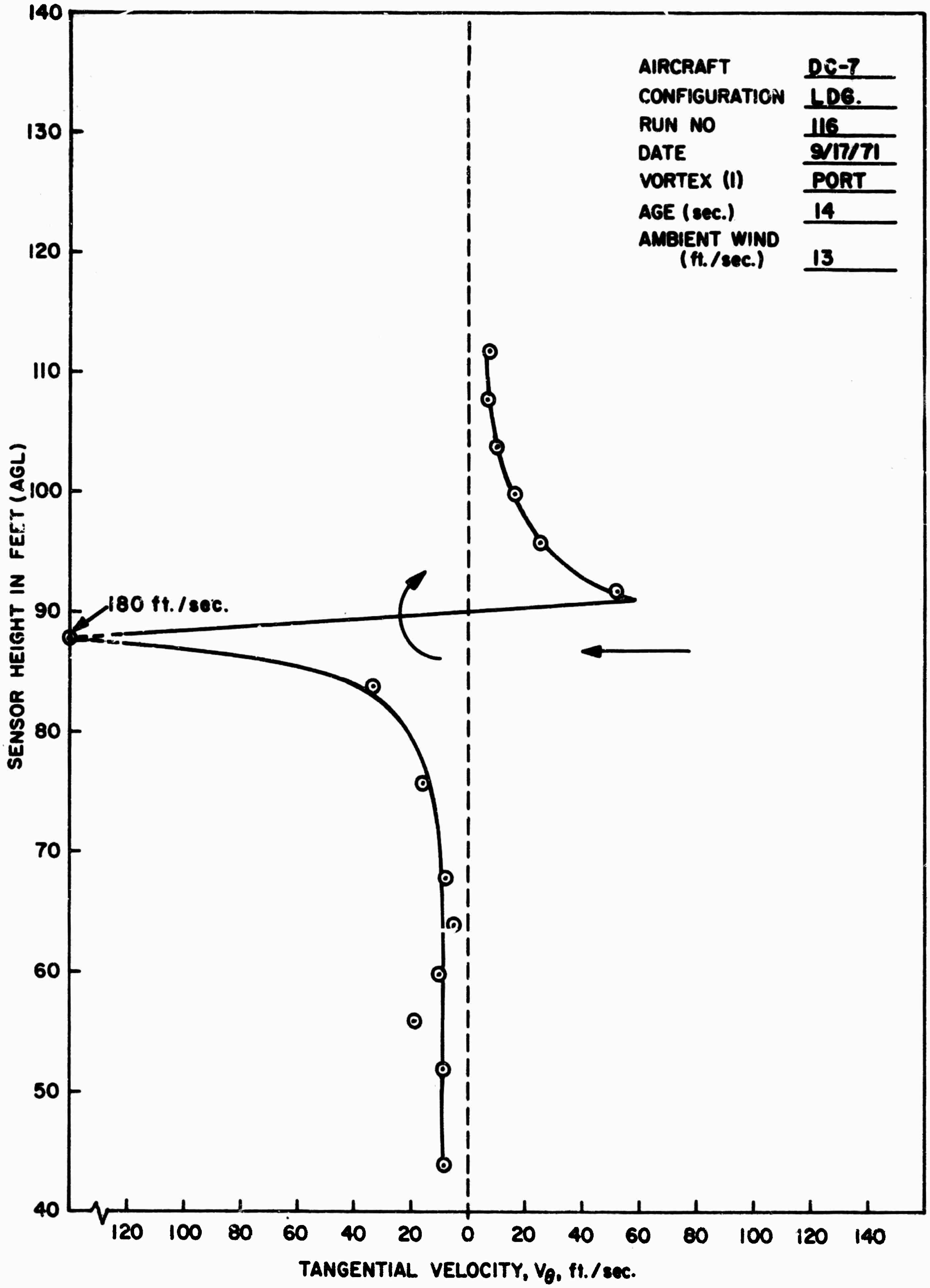
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 181
DATE 9/24/71
VORTEX (1) PORT
AGE (sec.) 13
AMBIENT WIND (ft./sec.) 14
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140



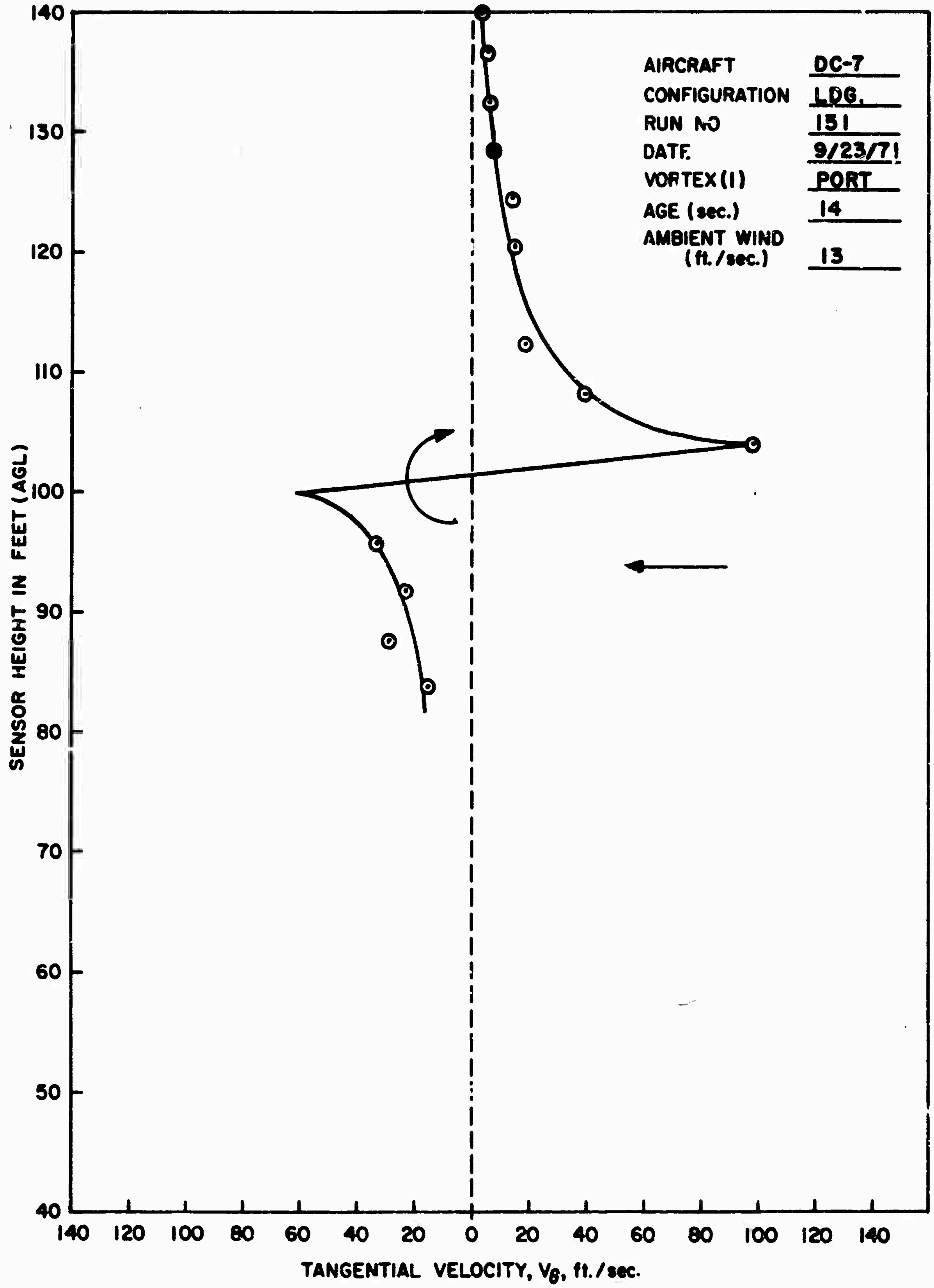
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 147
DATE 9/23/71
VORTEX (I) PORT
AGE (sec.) 13.5
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

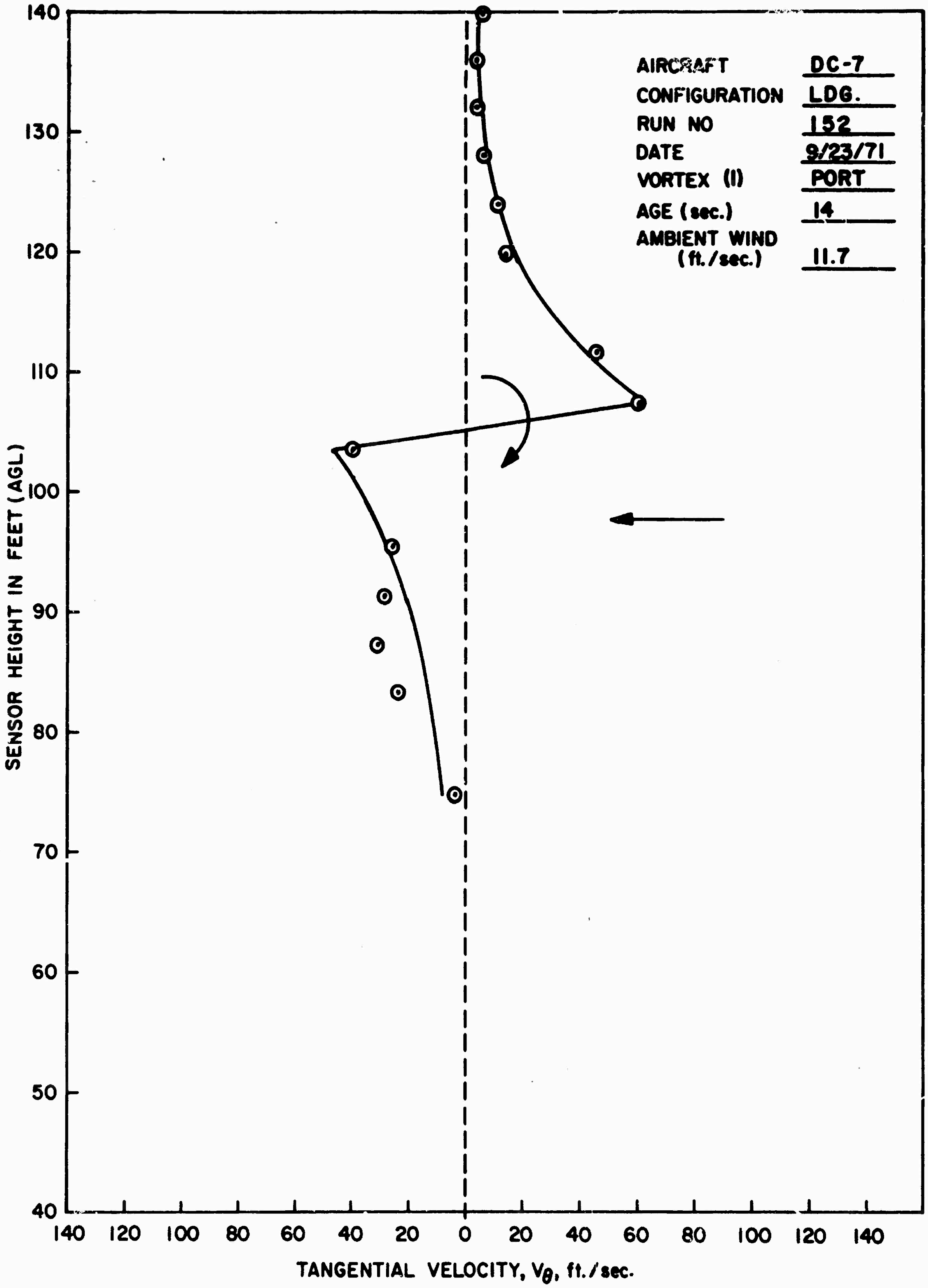

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 162
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 13.5
AMBIENT WIND (ft./sec.) 8.8
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 164
DATE 9/23/71
VORTEX (2) STBD.
AGE (sec.) 13.5
AMBIENT WIND (ft./sec.) 10.3
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

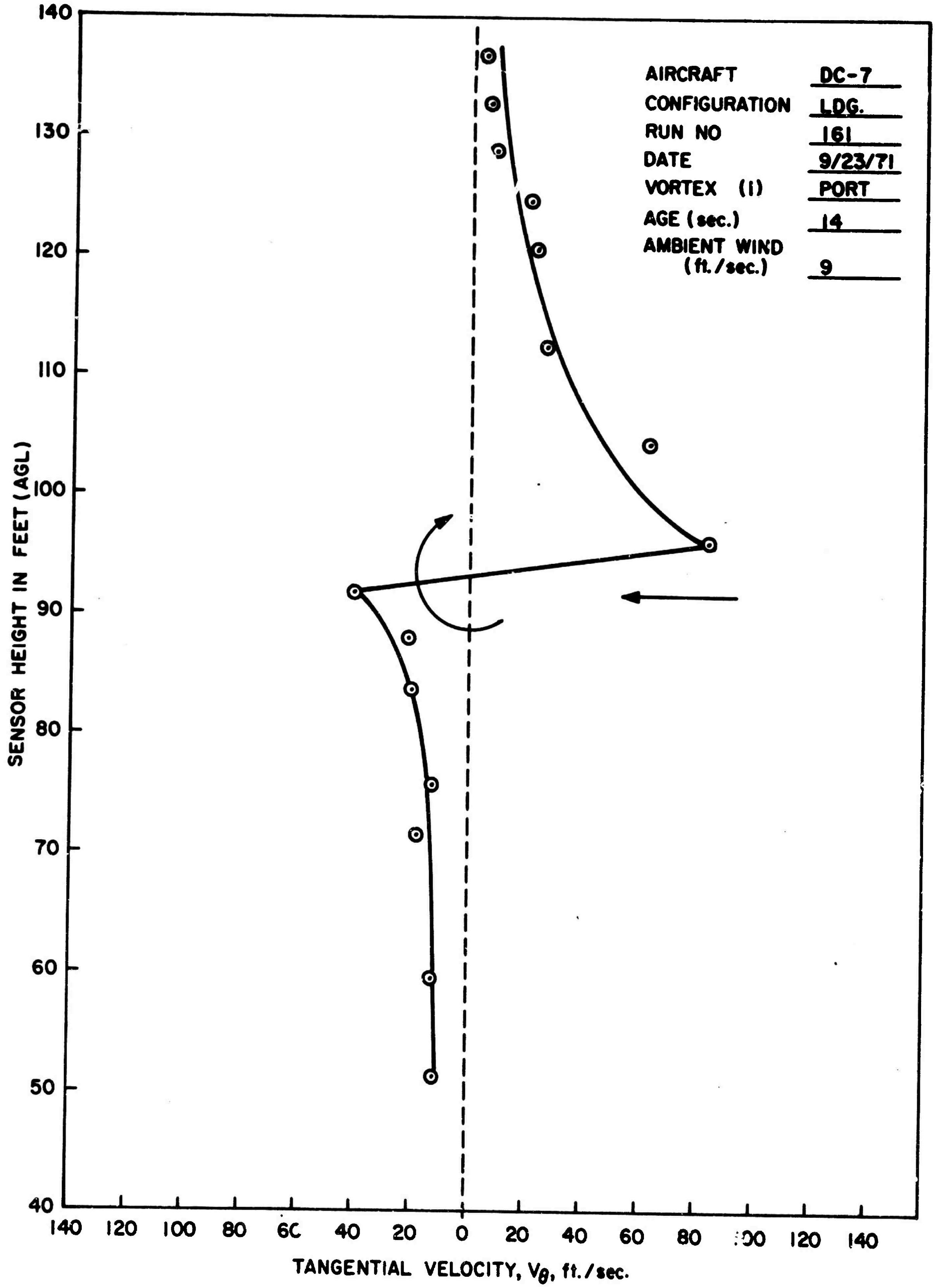


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 116
DATE 9/17/71
VORTEX (1) PORT
AGE (sec.) 14
AMBIENT WIND (ft./sec.) 13
180 ft./sec.
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

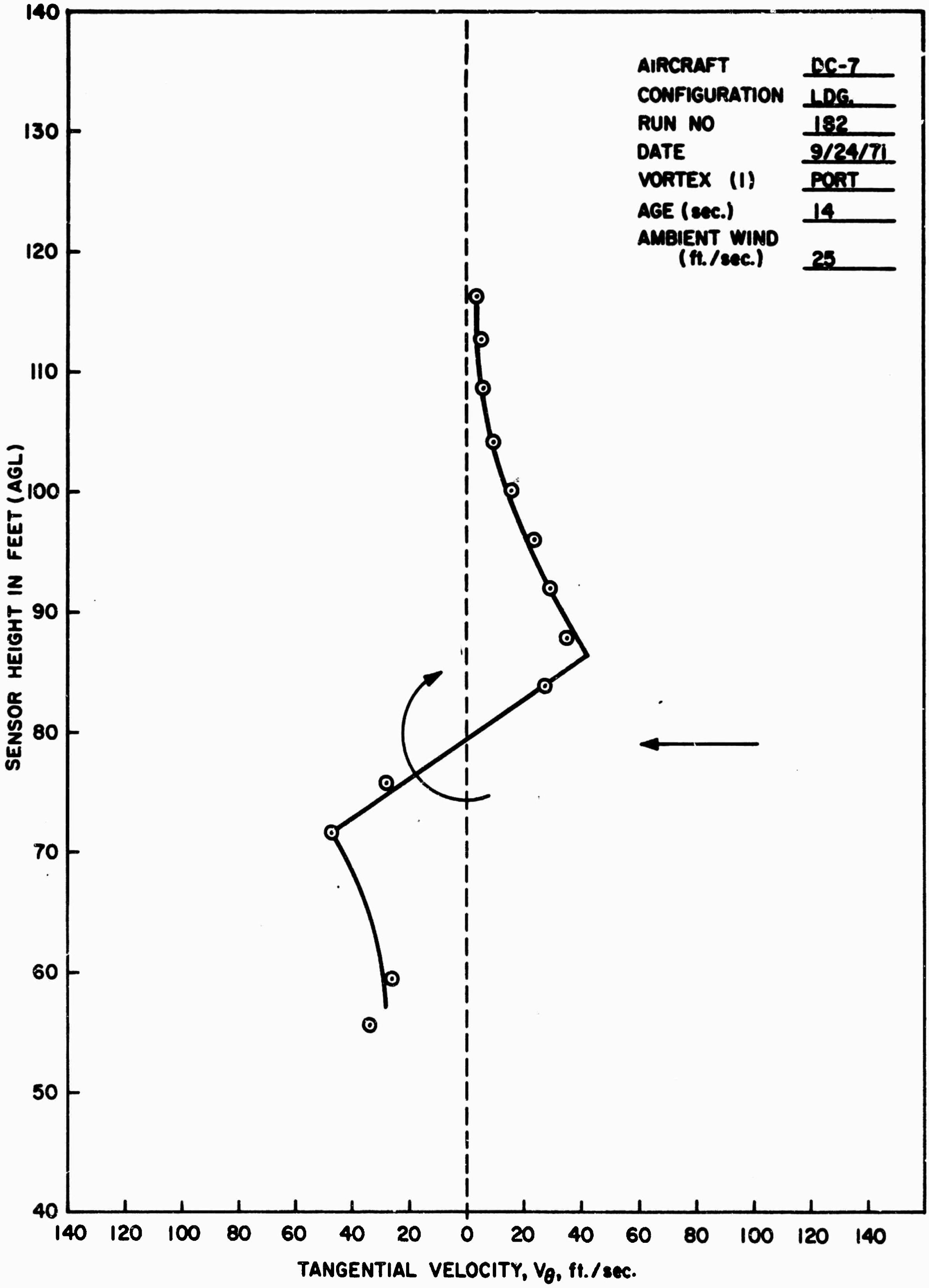

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 151
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 14
AMBIENT WIND (ft./sec.) 13
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

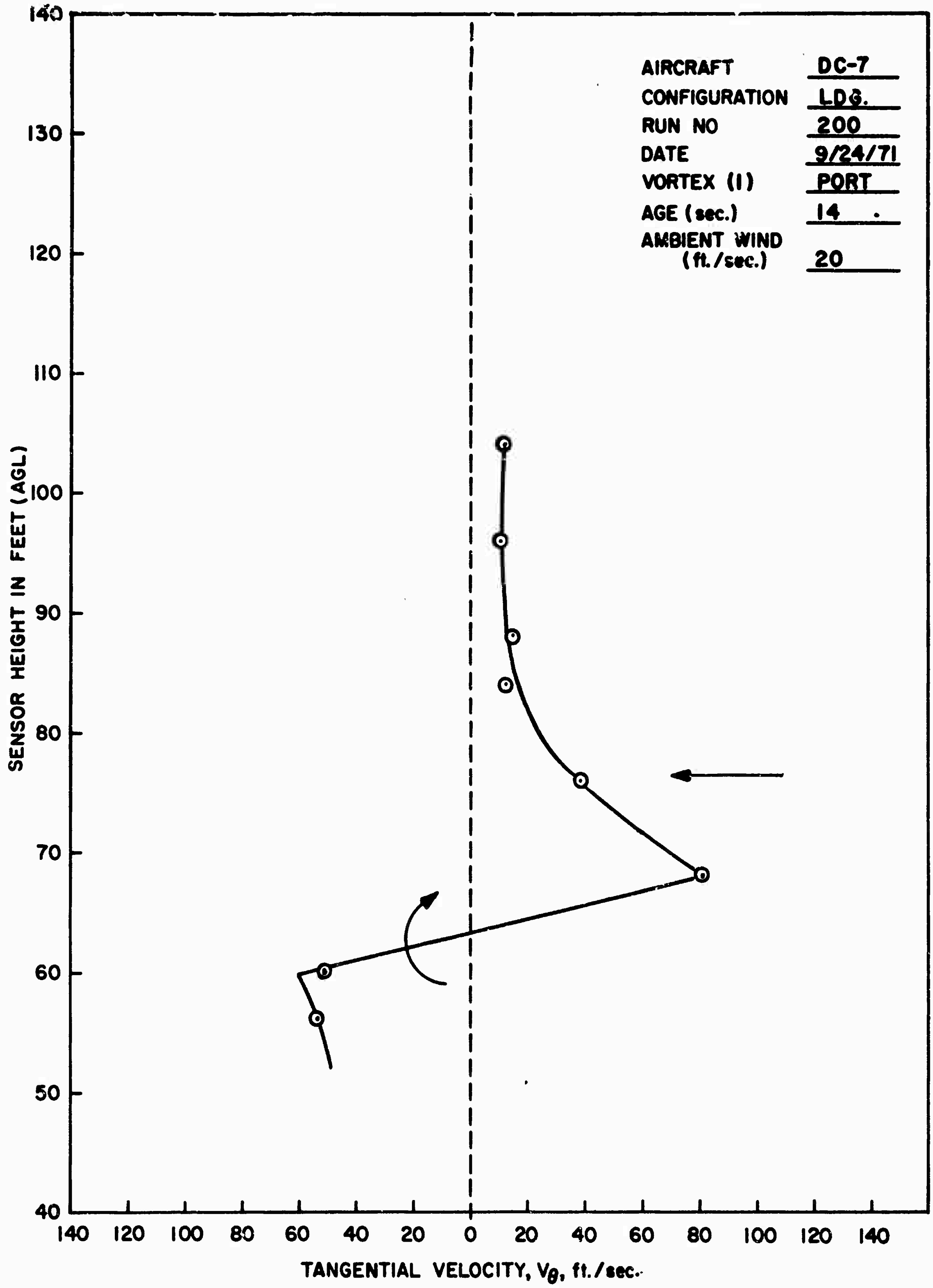


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 152
DATE 9/23/71
VORTEX (I) PORT
AGE (sec.) 14
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

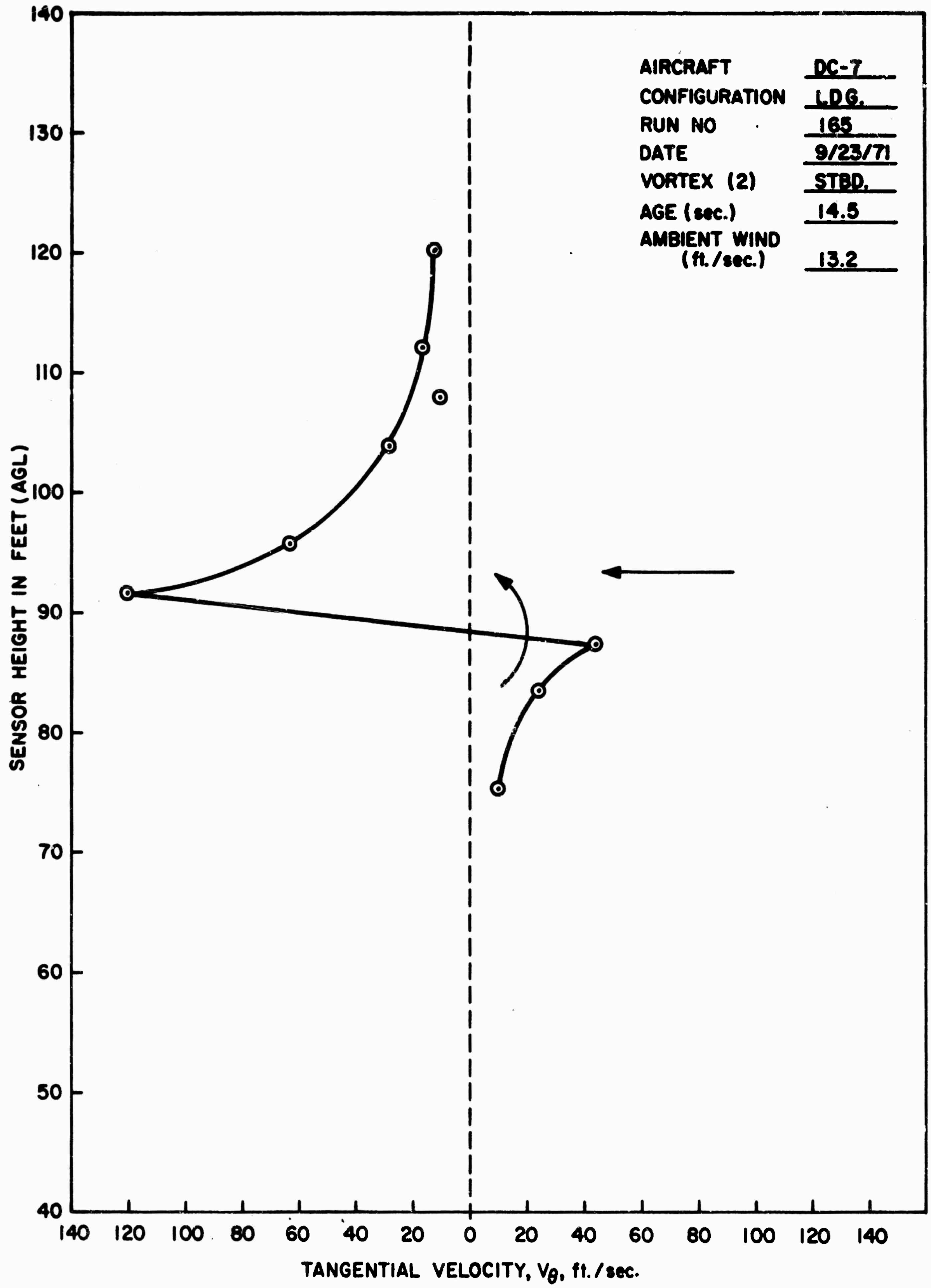


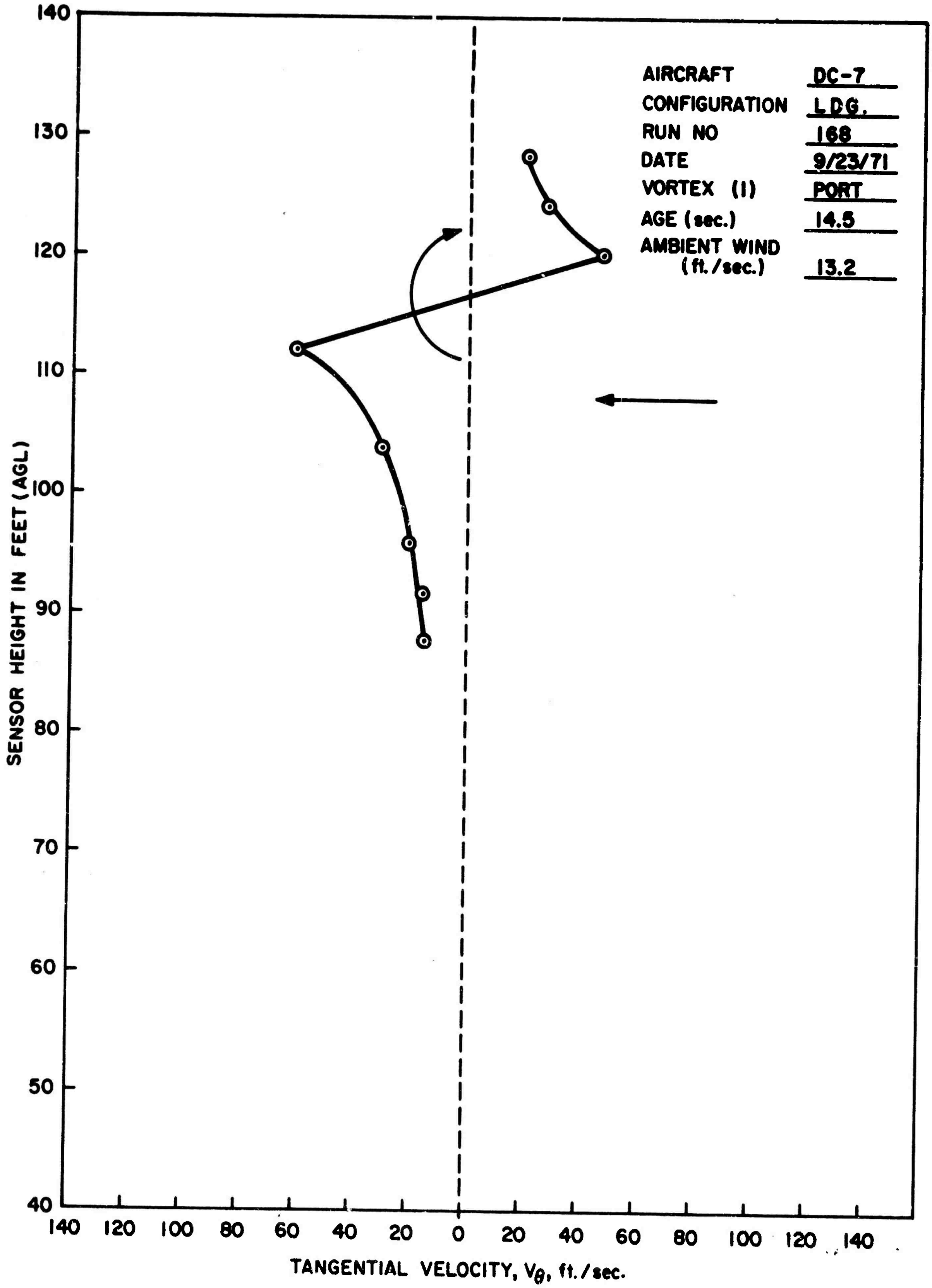
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 161
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 14
AMBIENT WIND (ft./sec.) 9
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 182
DATE 9/24/71
VORTEX (1) PORT
AGE (sec.) 14
AMBIENT WIND (ft./sec.) 25
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

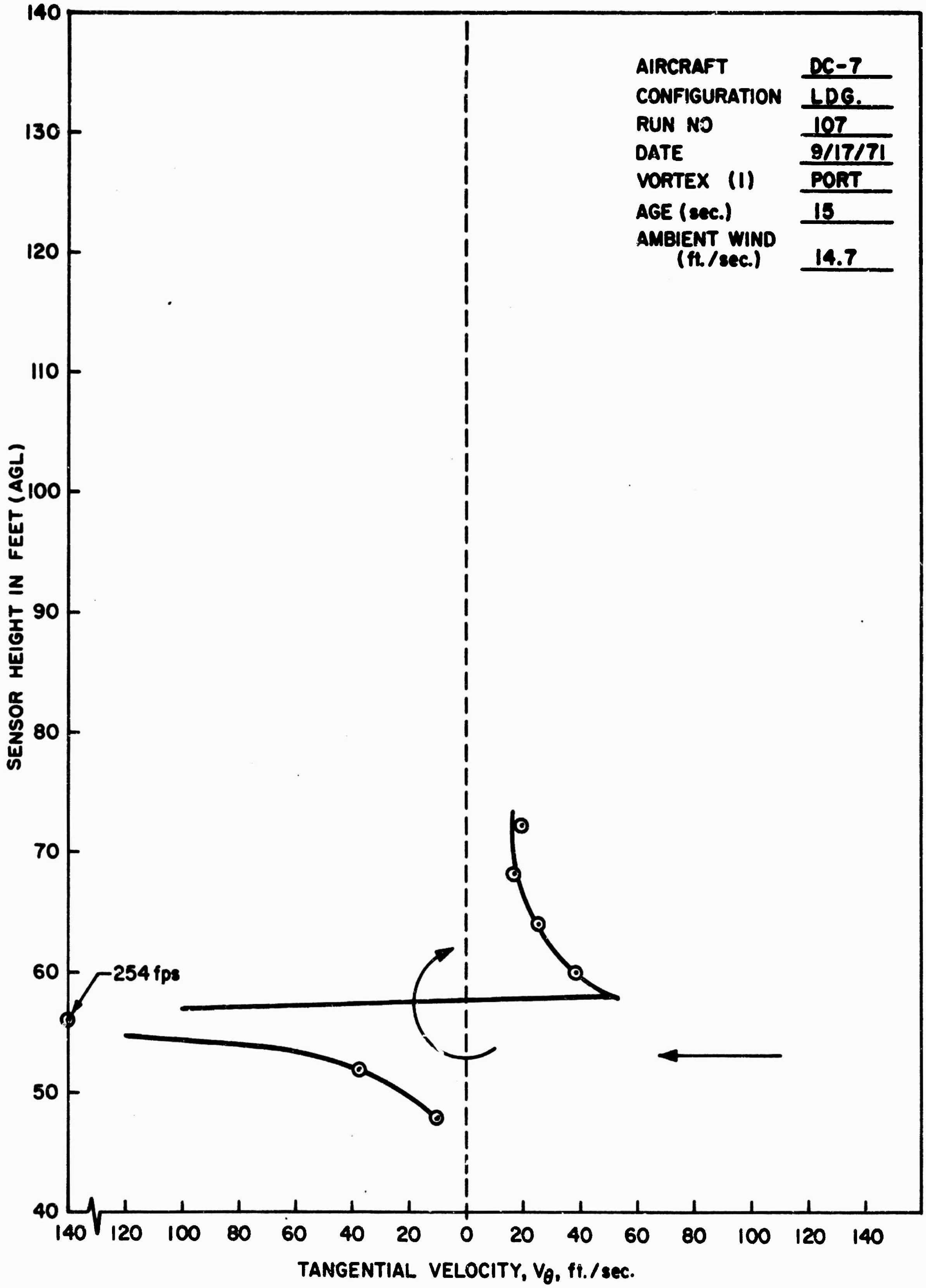


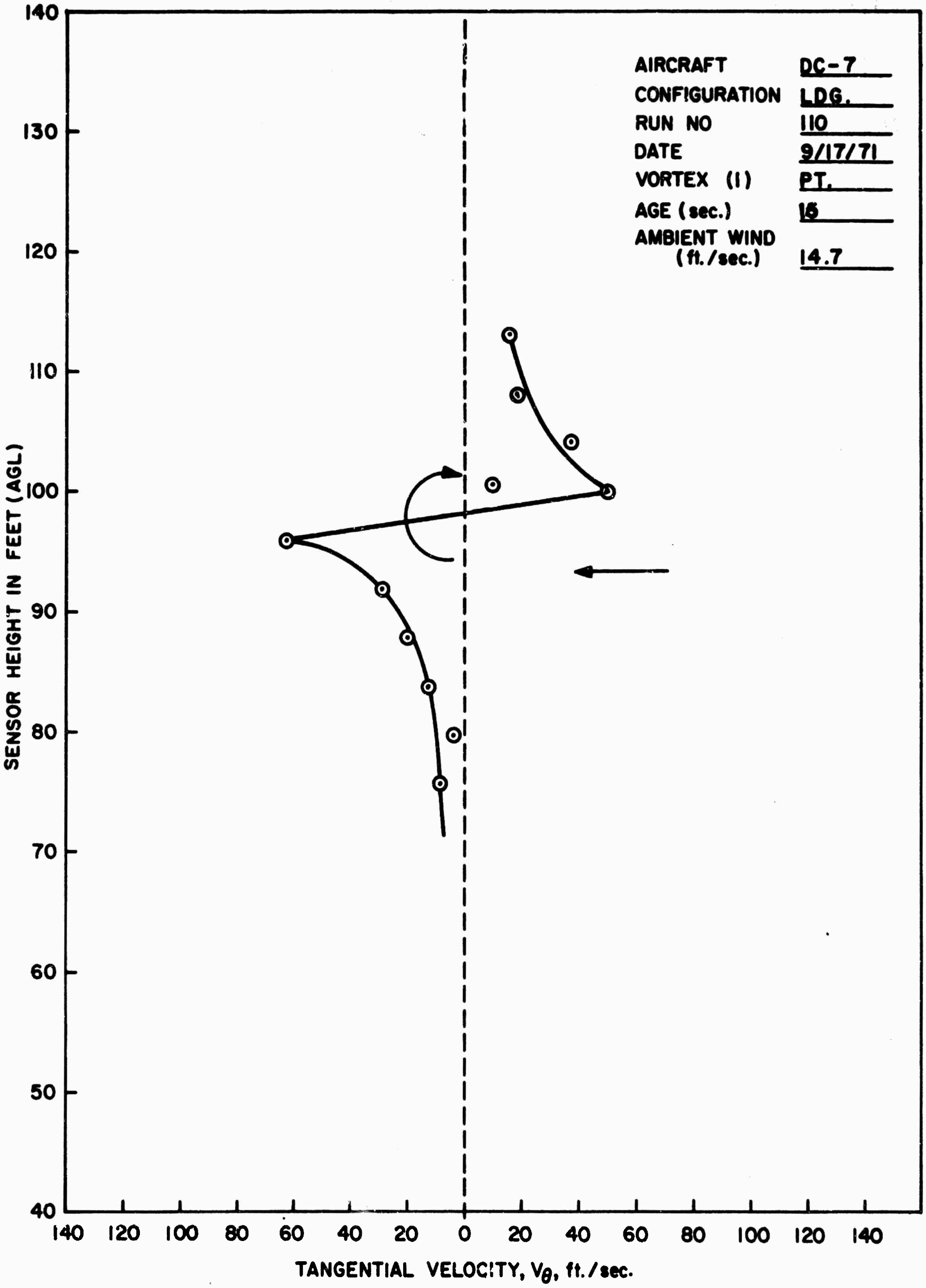
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 200
DATE 9/24/71
VORTEX (1) PORT
AGE (sec.) 14
AMBIENT WIND (ft./sec.) 20
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

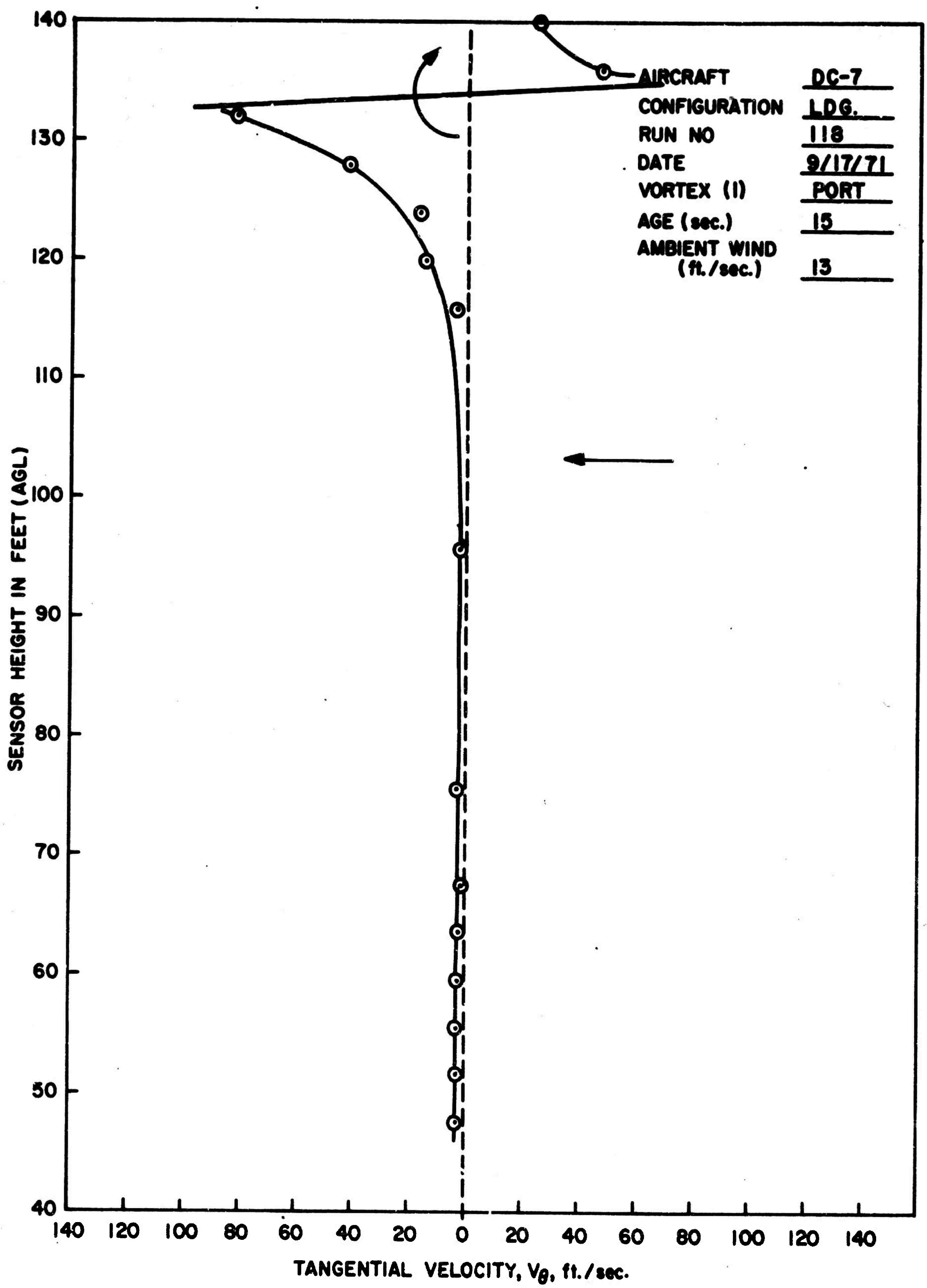

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 165
DATE 9/23/71
VORTEX (2) STBD.
AGE (sec.) 14.5
AMBIENT WIND (ft./sec.) 13.2
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140



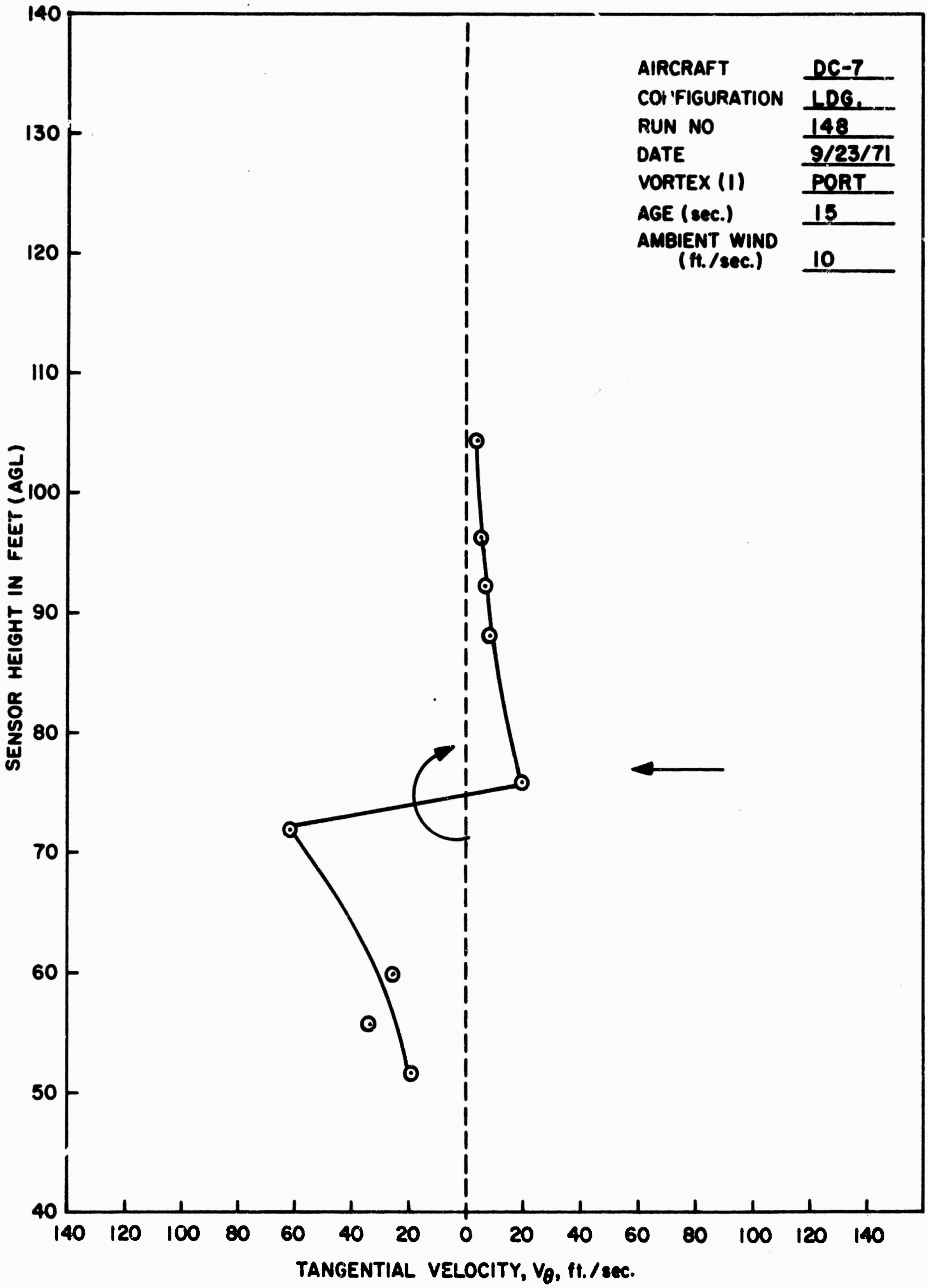
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 168
DATE 9/23/71
VORTEX (I) PORT
AGE (sec.) 14.5
AMBIENT WIND (ft./sec.) 13.2
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 107
DATE 9/17/71
VORTEX (1) PORT
AGE (sec.) 15
AMBIENT WIND (ft./sec.) 14.7
254 fps
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.

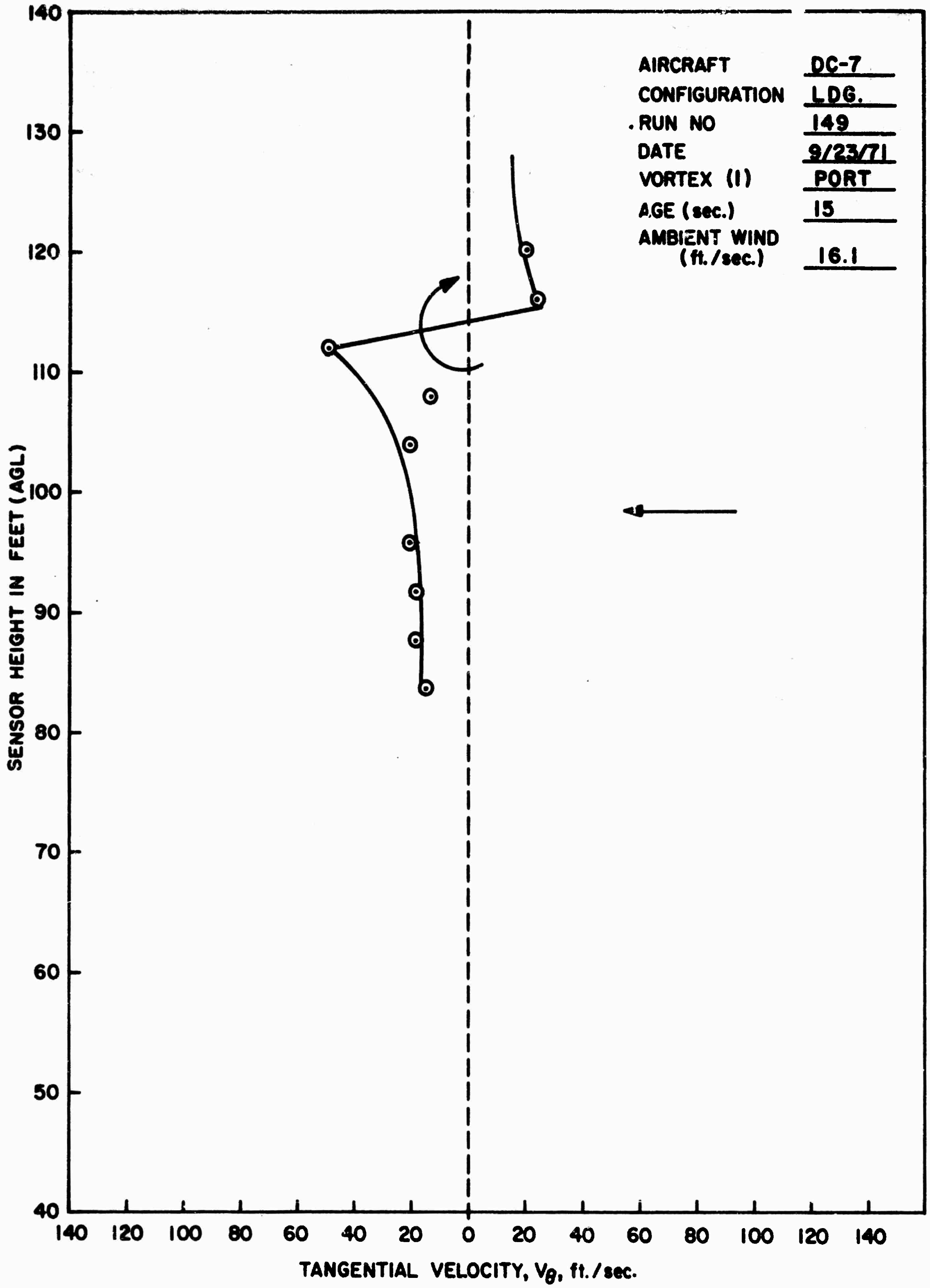

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 110
DATE 9/17/71
VORTEX (1) PT.
AGE (sec.) 16
AMBIENT WIND (ft./sec.) 14.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



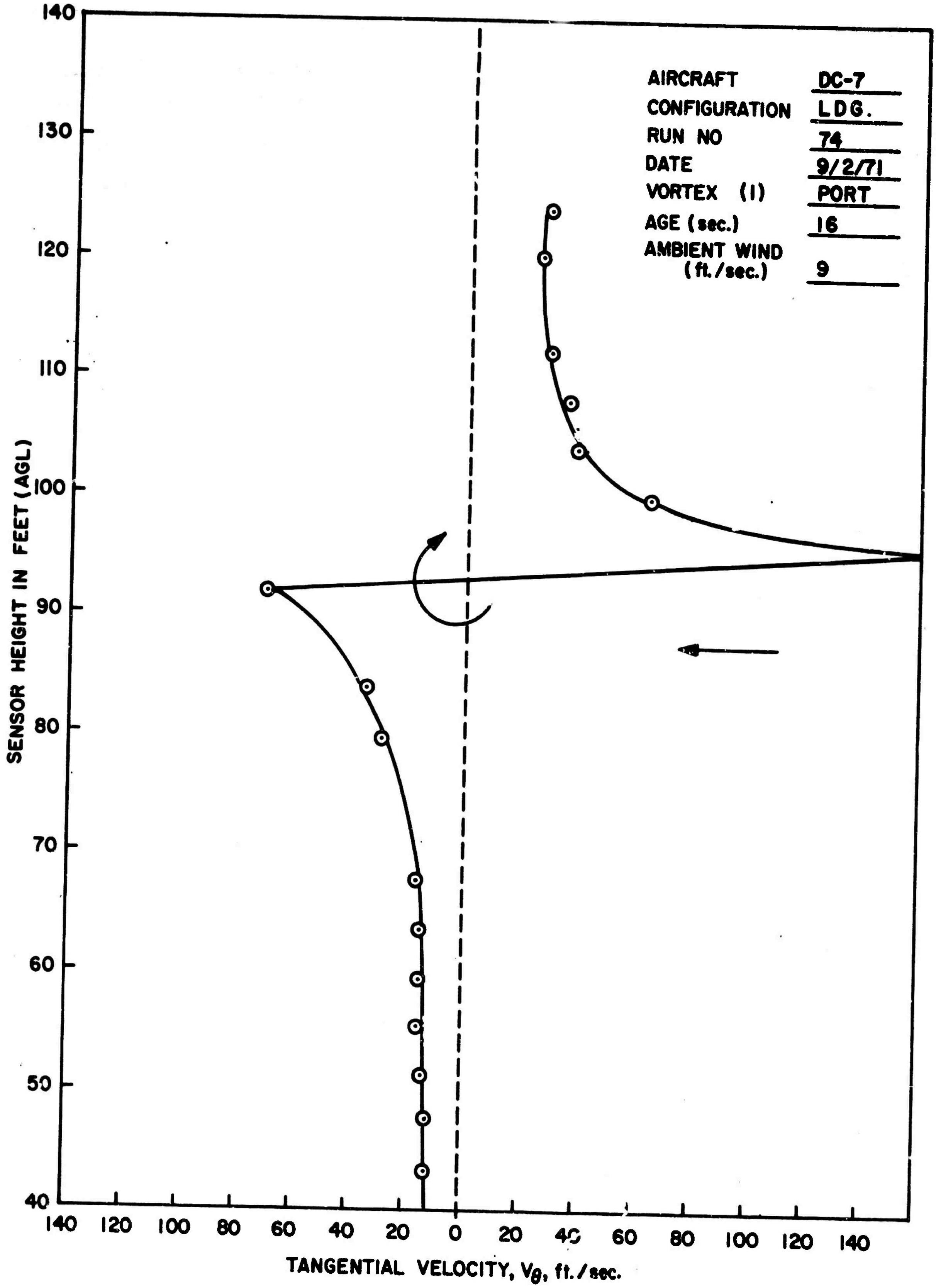
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 118
DATE 9/17/71
VORTEX (1) PORT
AGE (sec.) 15
AMBIENT WIND (ft./sec.) 13
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

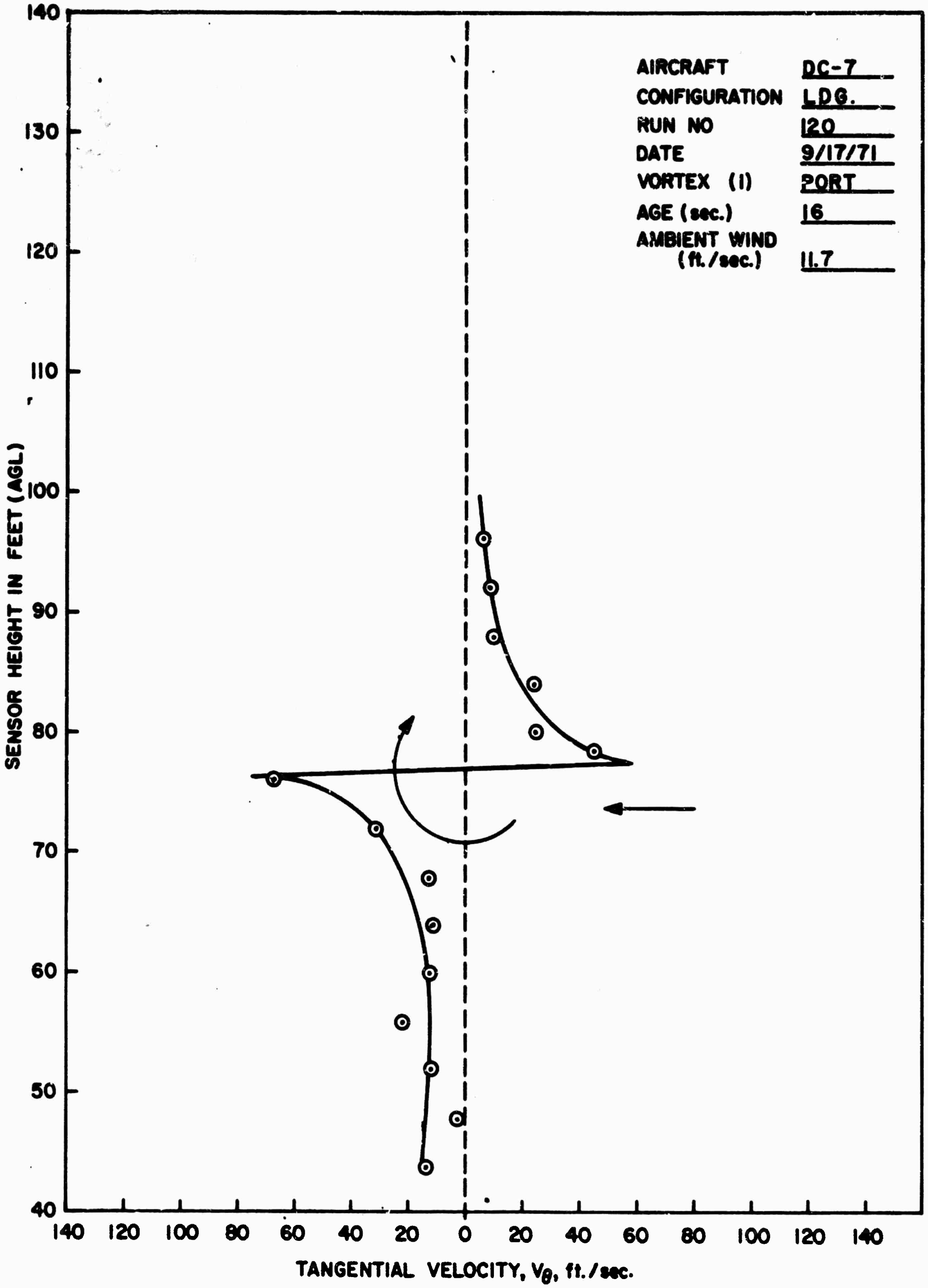


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 148
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 15
AMBIENT WIND (ft./sec.) 10
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

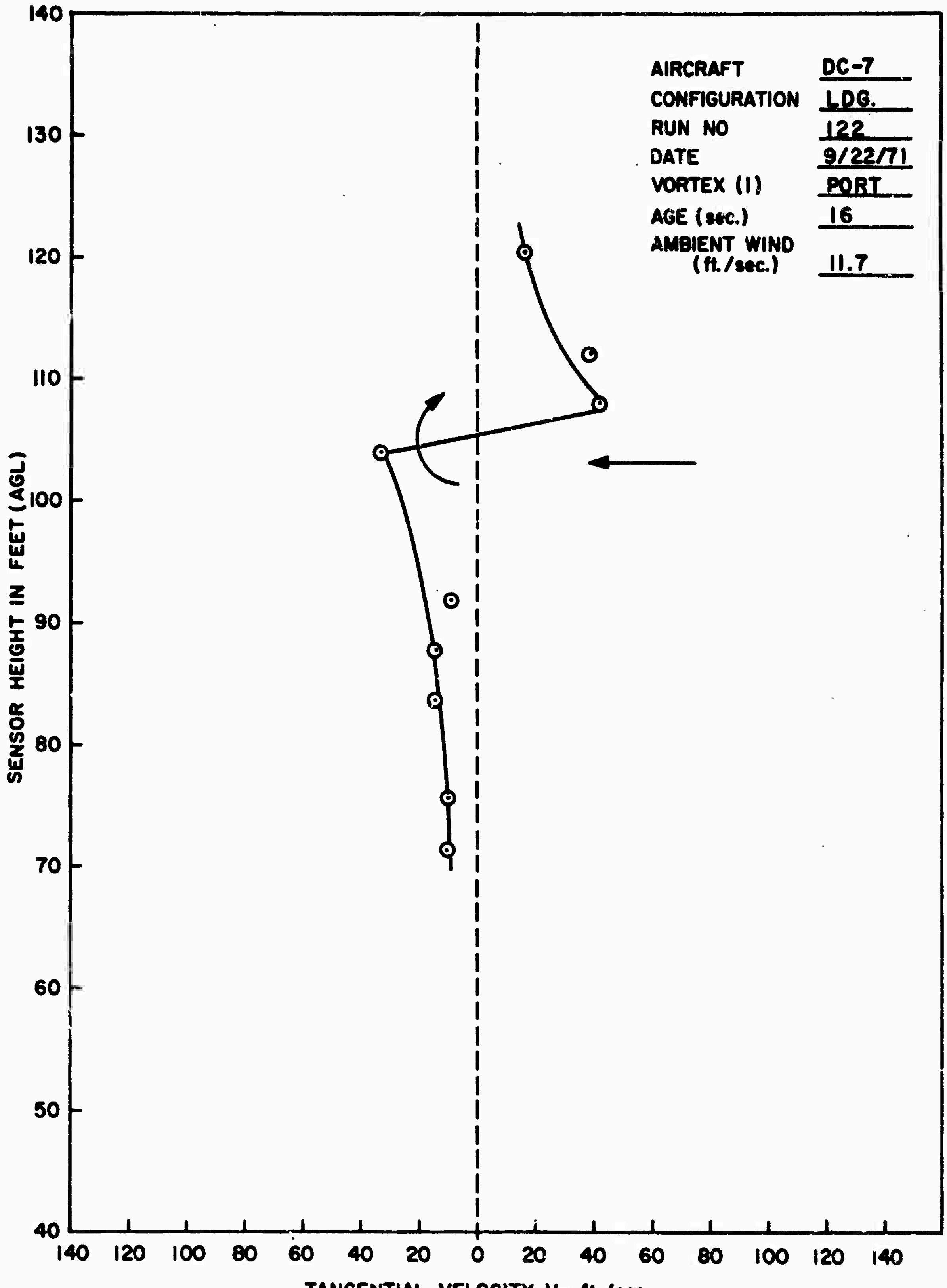


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 149
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 15
AMBIENT WIND (ft./sec.) 16.1
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

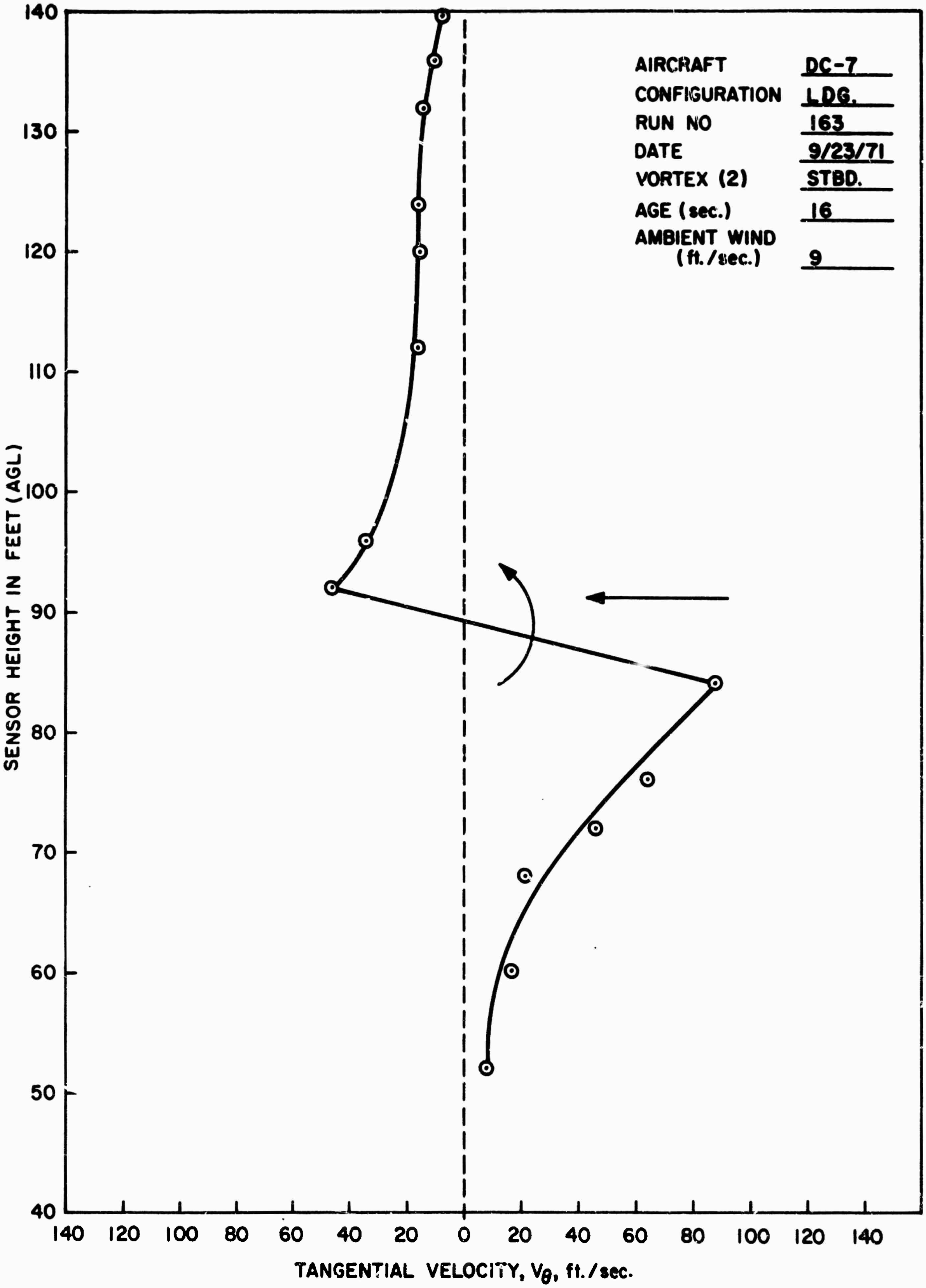

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 74
DATE 9/2/71
VORTEX (1) PORT
AGE (sec.) 16
AMBIENT WIND (ft./sec.) 9
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

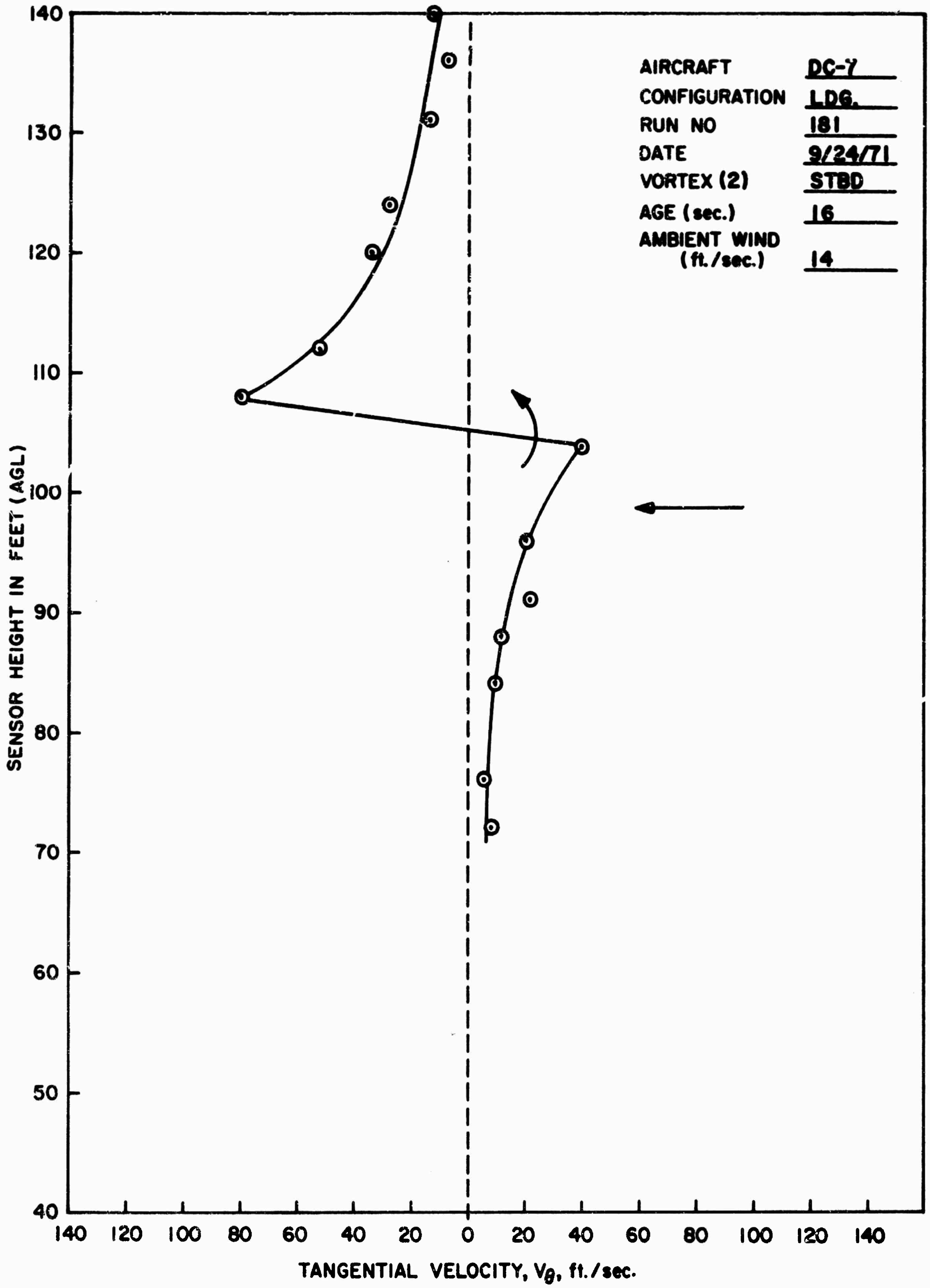


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 120
DATE 9/17/71
VORTEX (1) PORT
AGE (sec.) 16
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

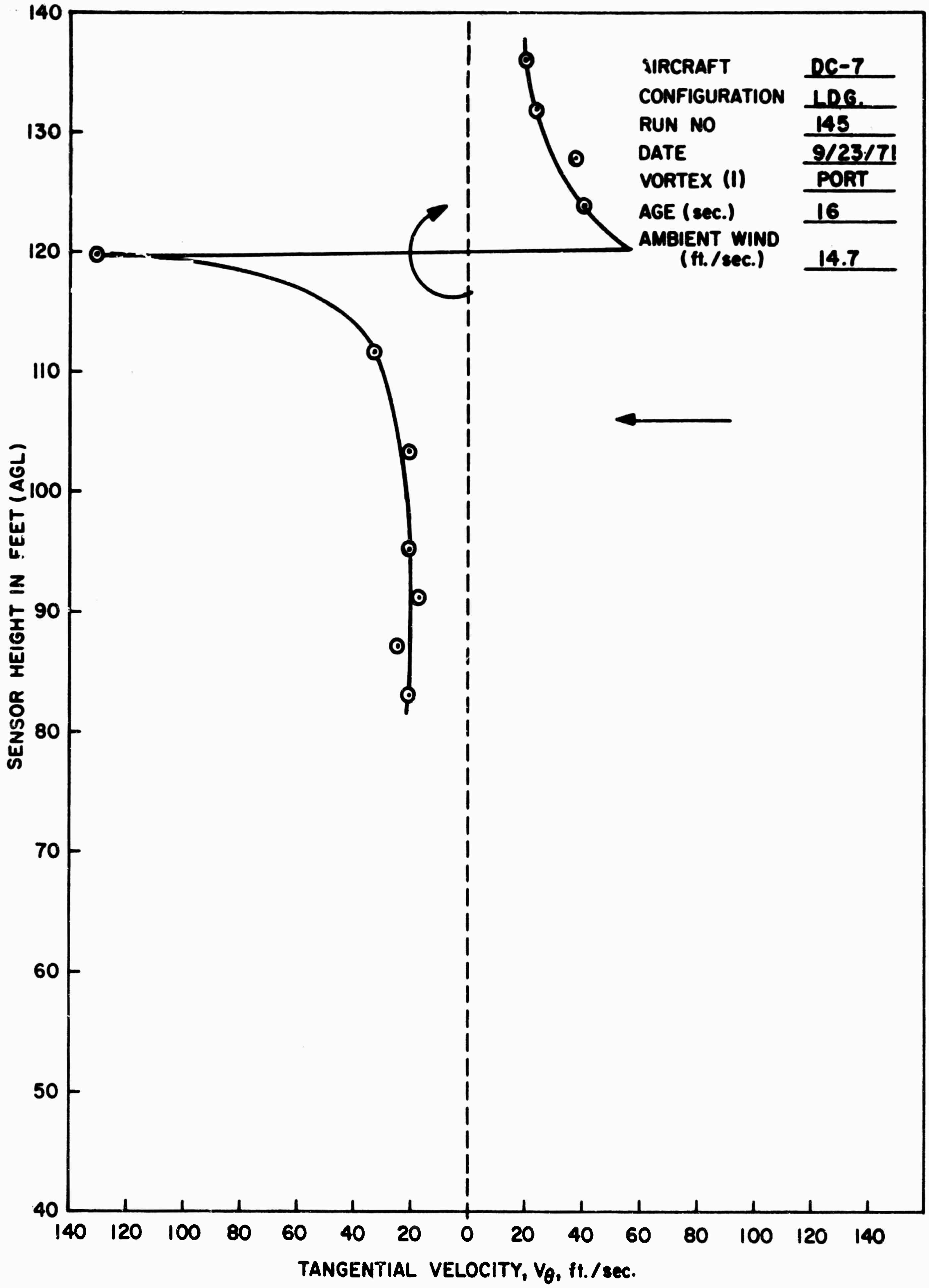


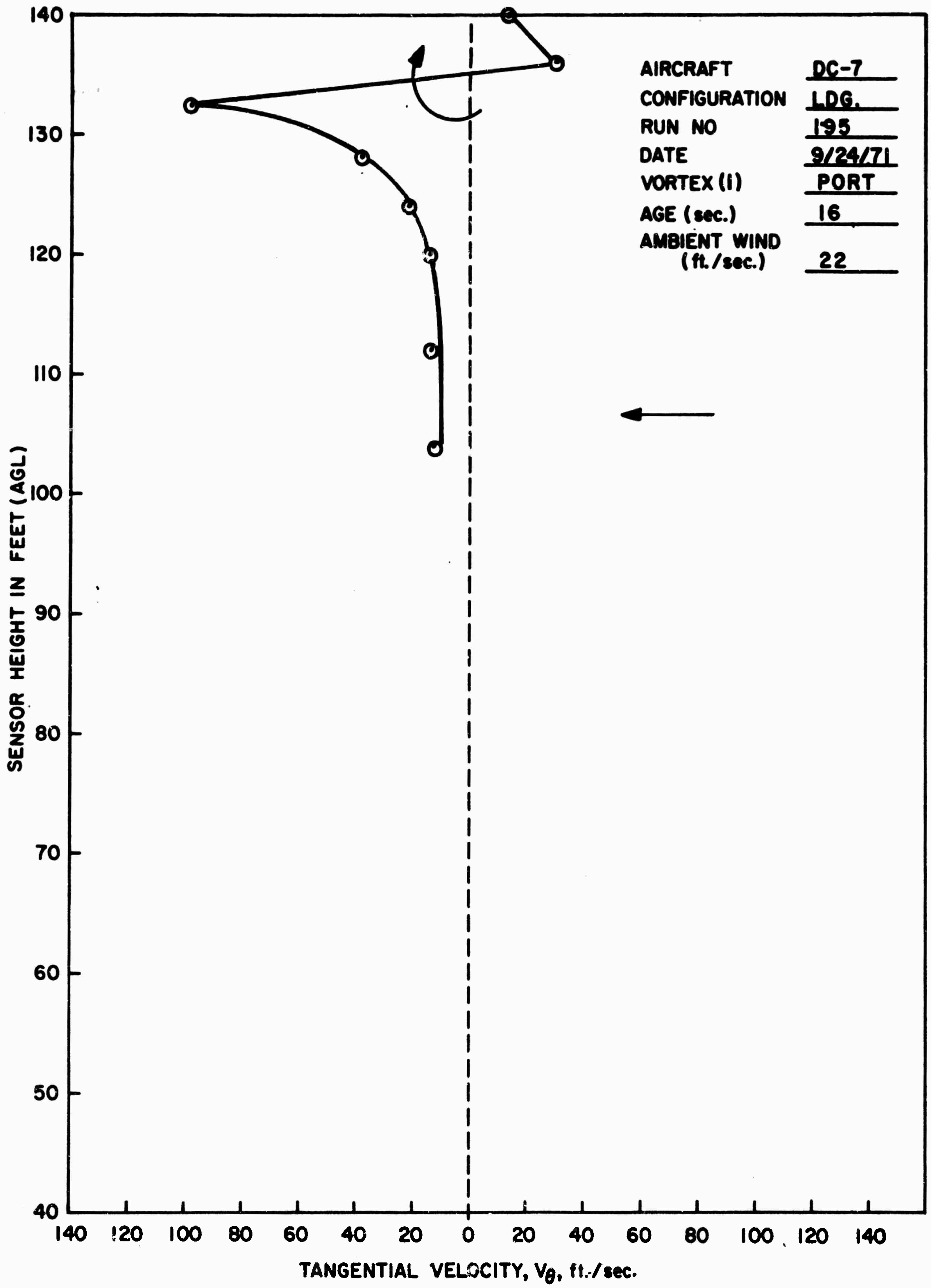
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 122
DATE 9/22/71
VORTEX (1) PORT
AGE (sec.) 16
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 163
DATE 9/23/71
VORTEX (2) STBD.
AGE (sec.) 16
AMBIENT WIND (ft./sec.) 9
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

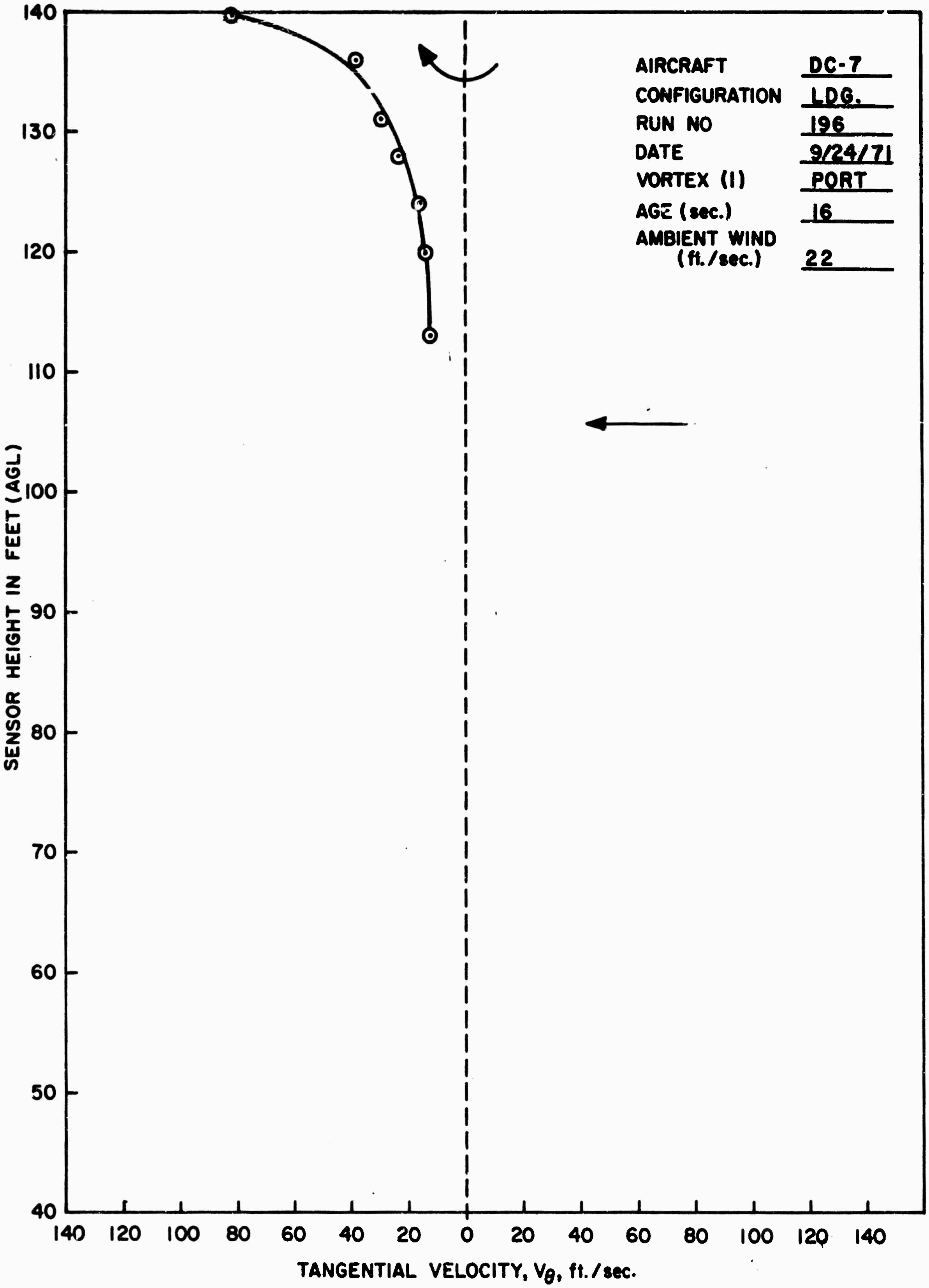


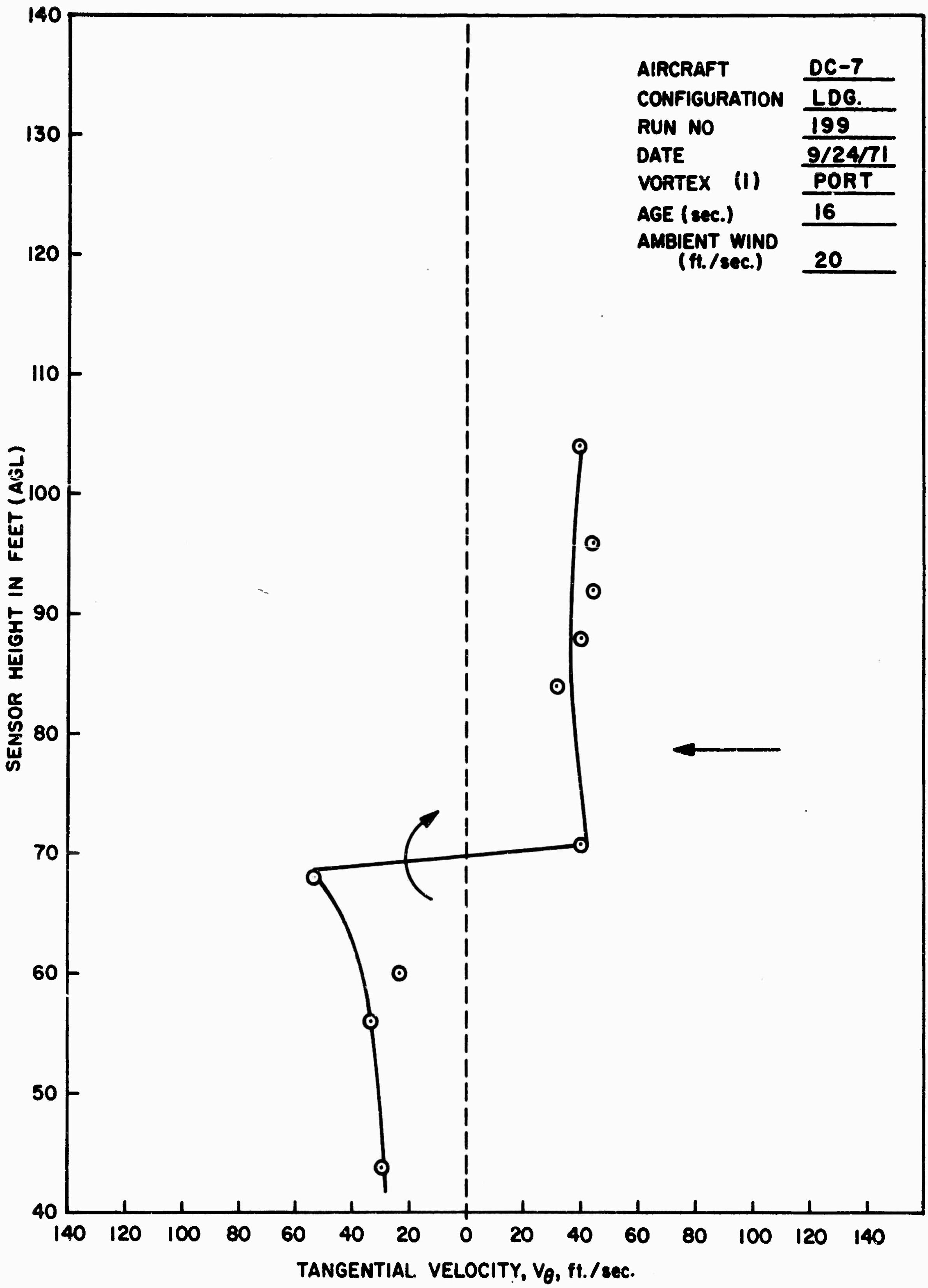
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 181
DATE 9/24/71
VORTEX (2) STBD
AGE (sec.) 16
AMBIENT WIND (ft./sec.) 14
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

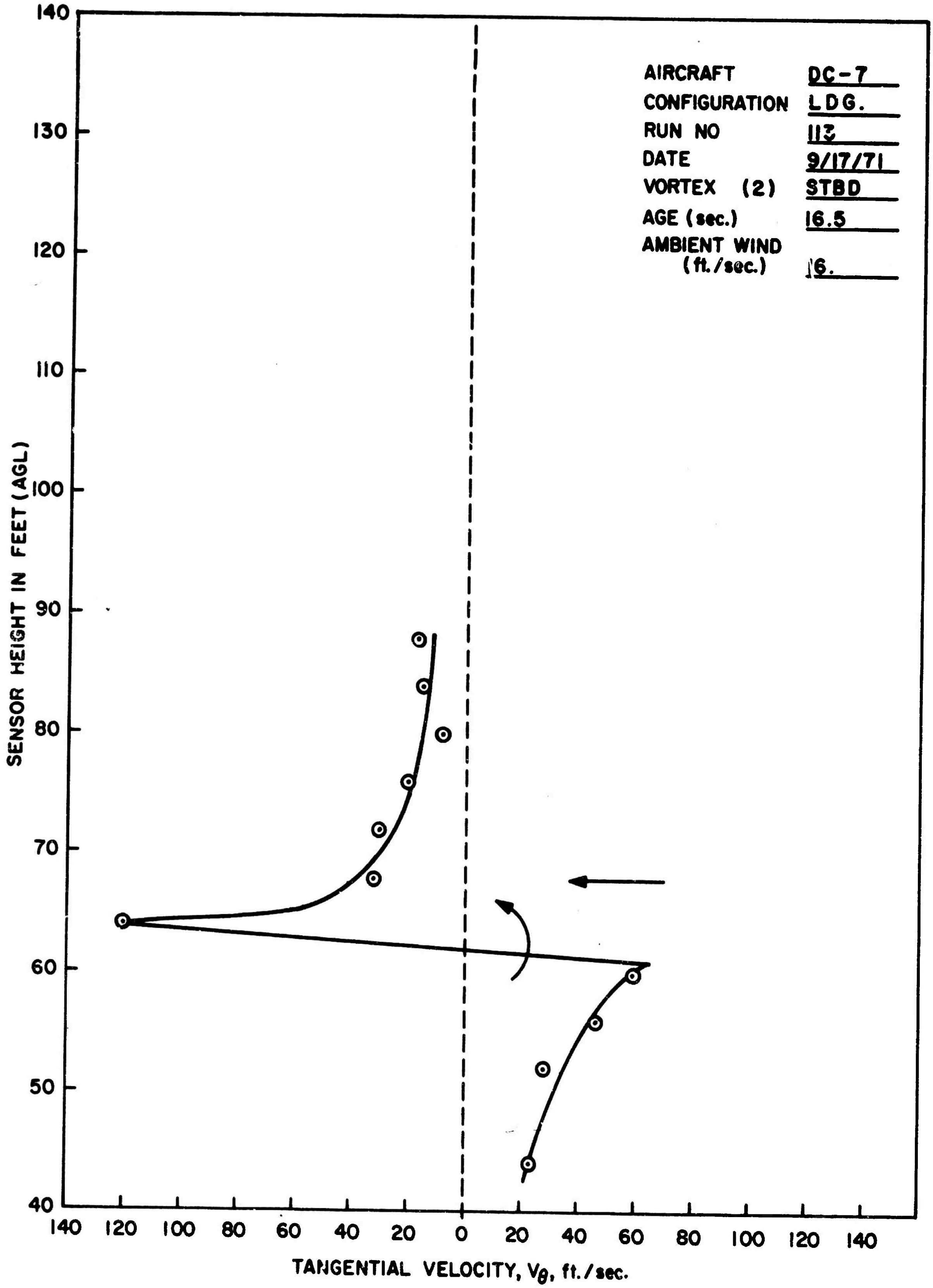

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 145
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 16
AMBIENT WIND (ft./sec.) 14.7
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, Vθ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

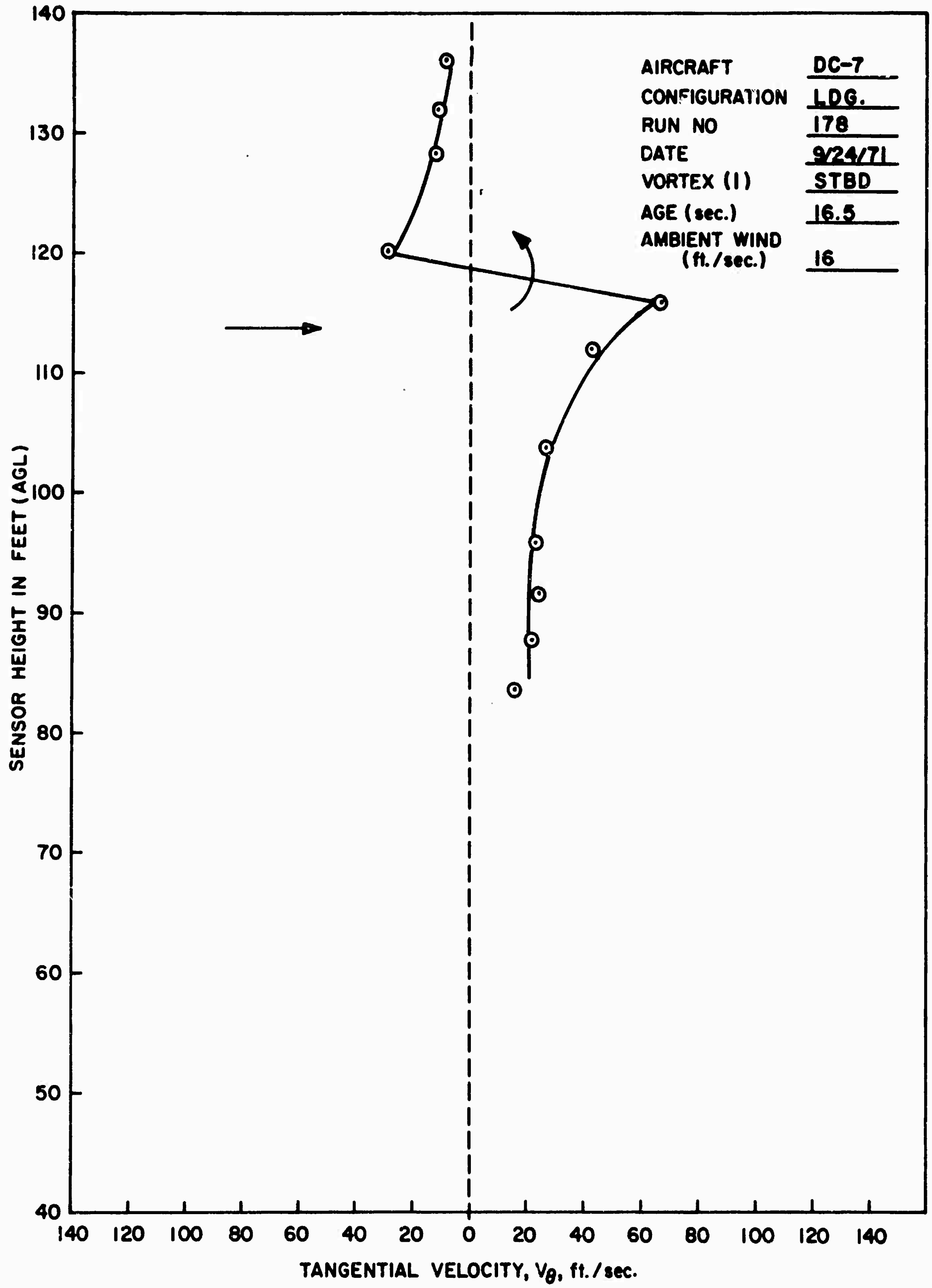


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 195
DATE 9/24/71
VORTEX (1) PORT
AGE (sec.) 16
AMBIENT WIND (ft./sec.) 22
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

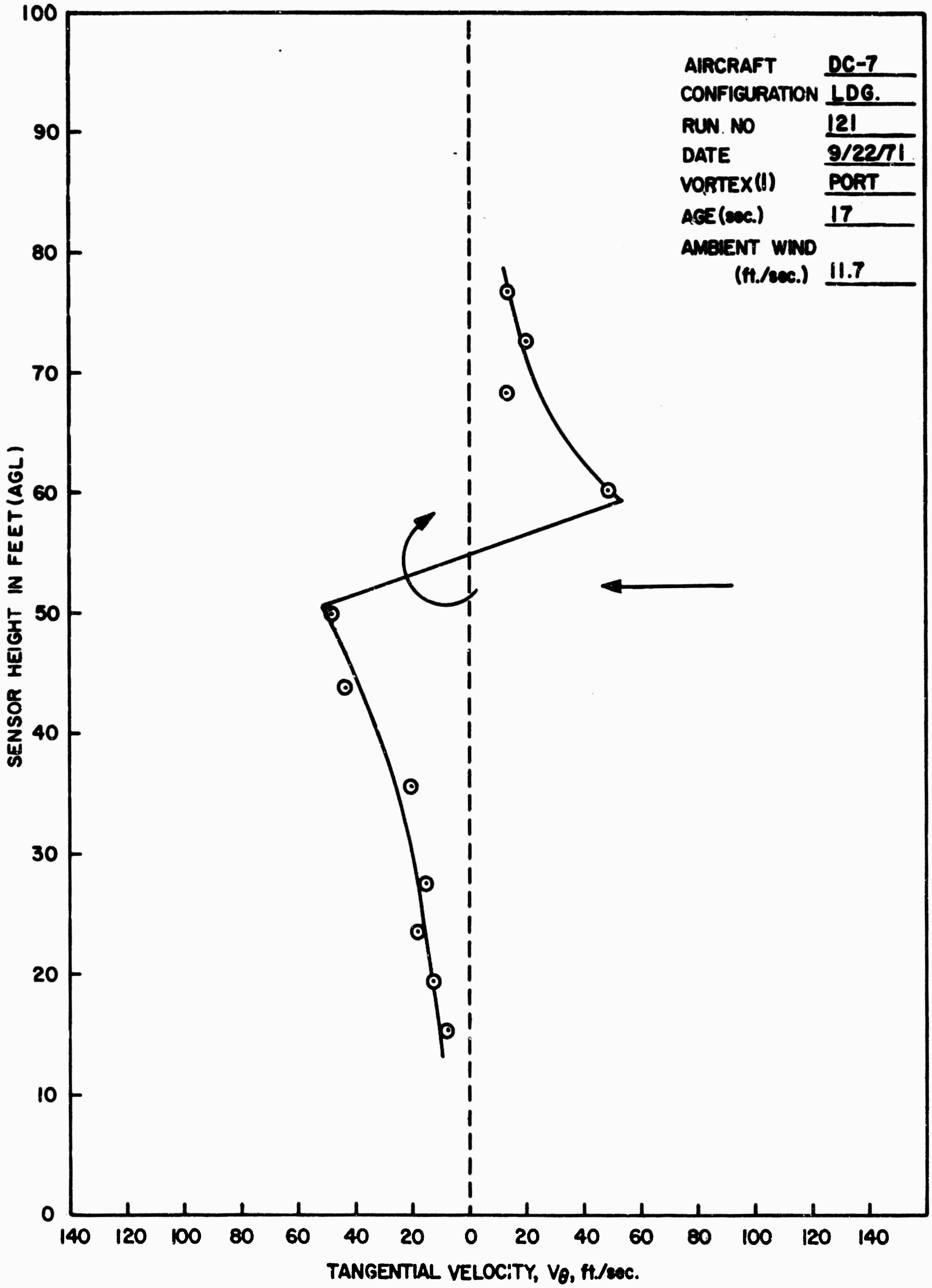

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 196
DATE 9/24/71
VORTEX (1) PORT
AGE (sec.) 16
AMBIENT WIND (ft./sec.) 22
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

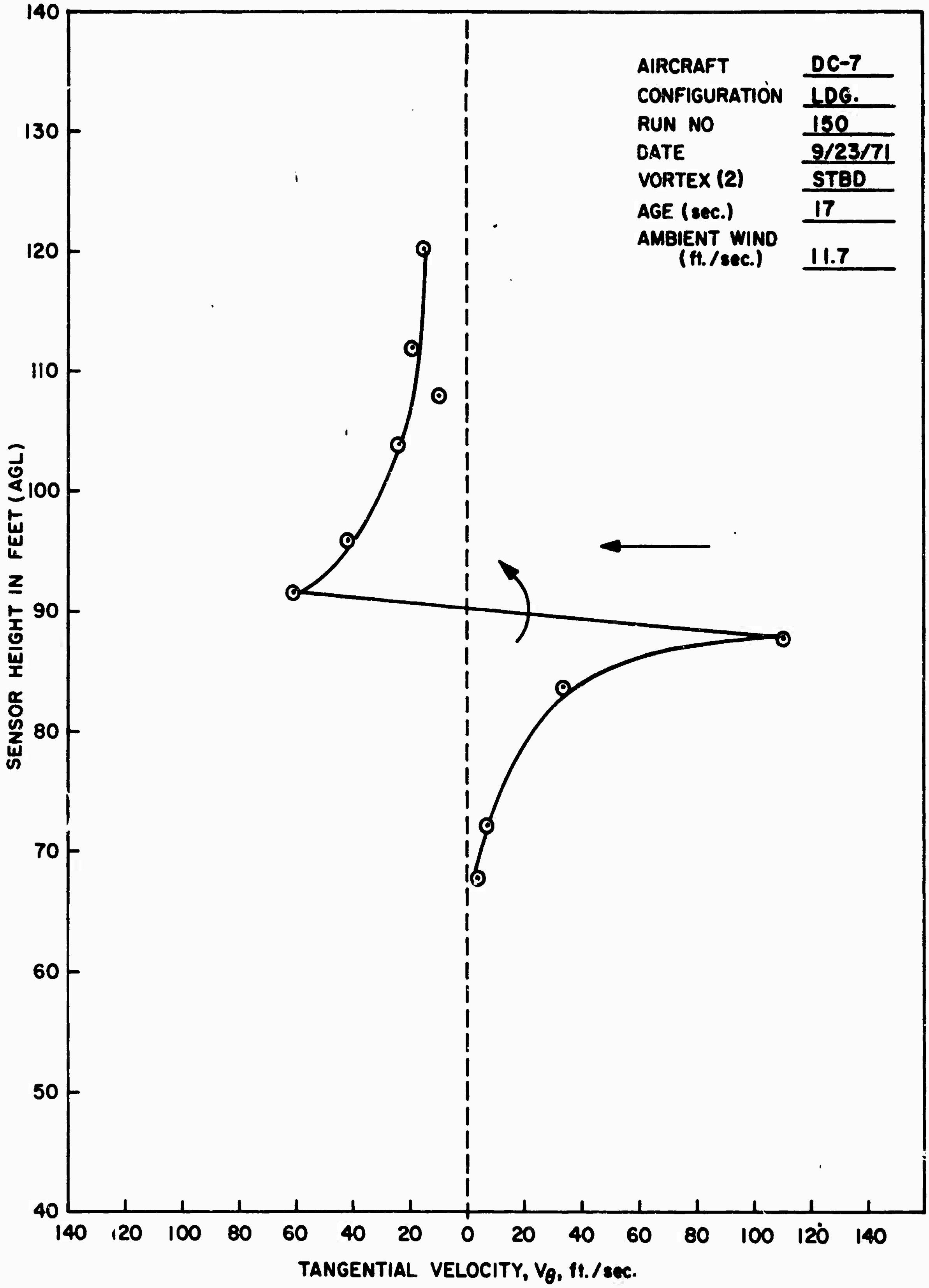

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 199
DATE 9/24/71
VORTEX (1) PORT
AGE (sec.) 16
AMBIENT WIND (ft./sec.) 20
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 113
DATE 9/17/71
VORTEX (2) STBD
AGE (sec.) 16.5
AMBIENT WIND (ft./sec.) 16.
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, Vθ, ft./sec.

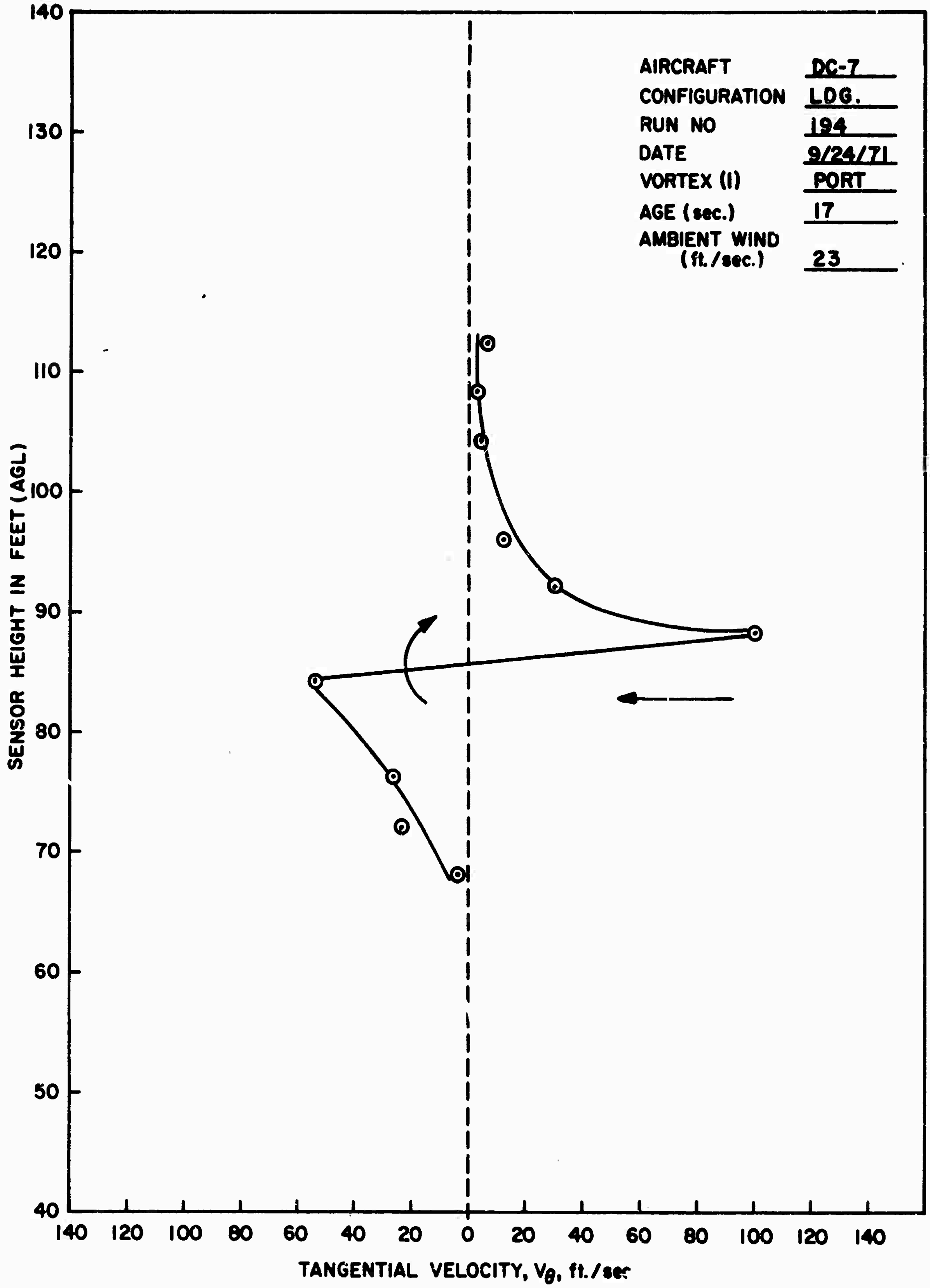


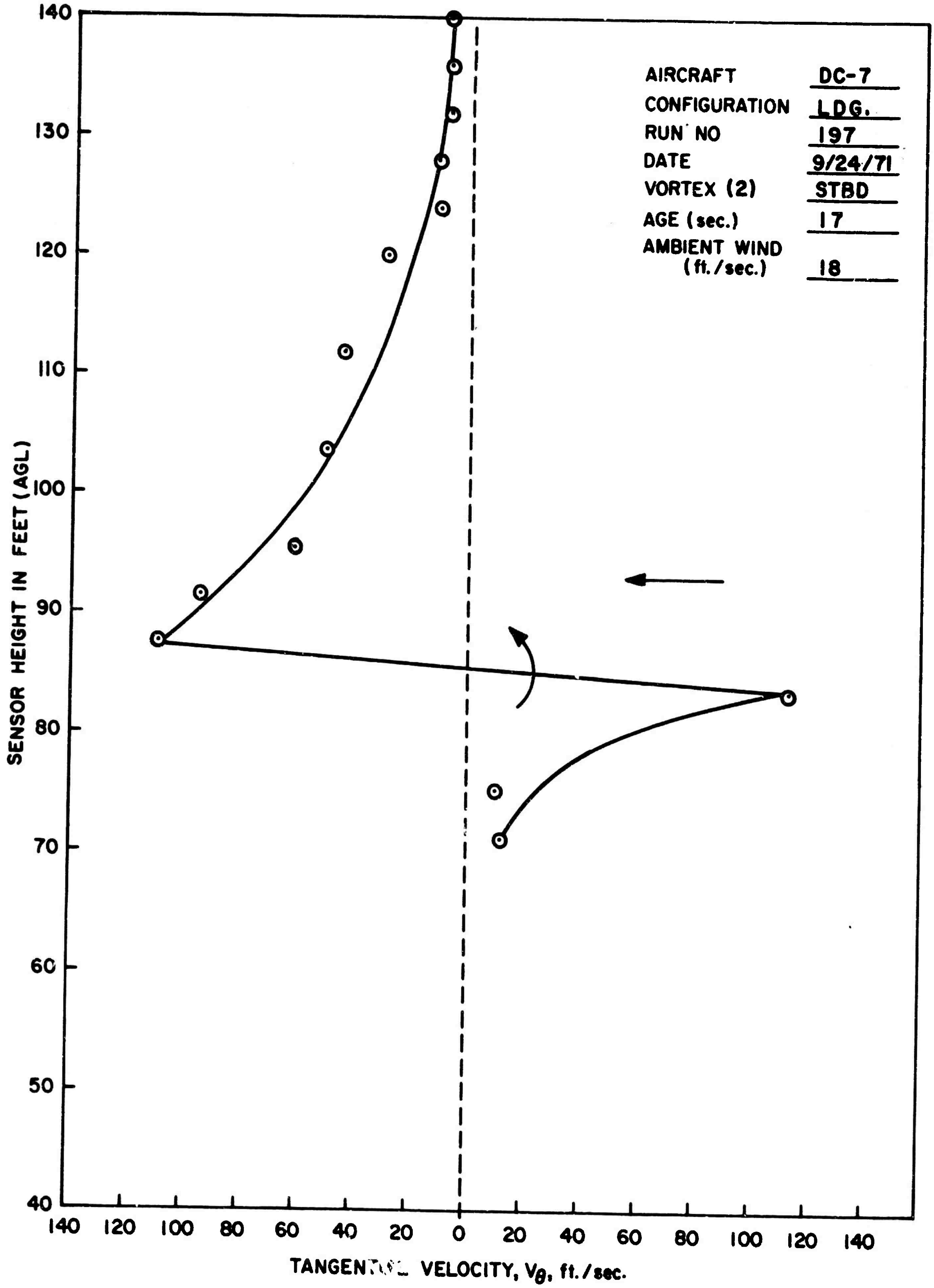
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 178
DATE 9/24/71
VORTEX (1) STBD
AGE (sec.) 16.5
AMBIENT WIND (ft./sec.) 16
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN. NO 121
DATE 9/22/71
VORTEX(1) PORT
AGE (sec.) 17
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
100
90
80
70
60
50
40
30
20
10
0
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

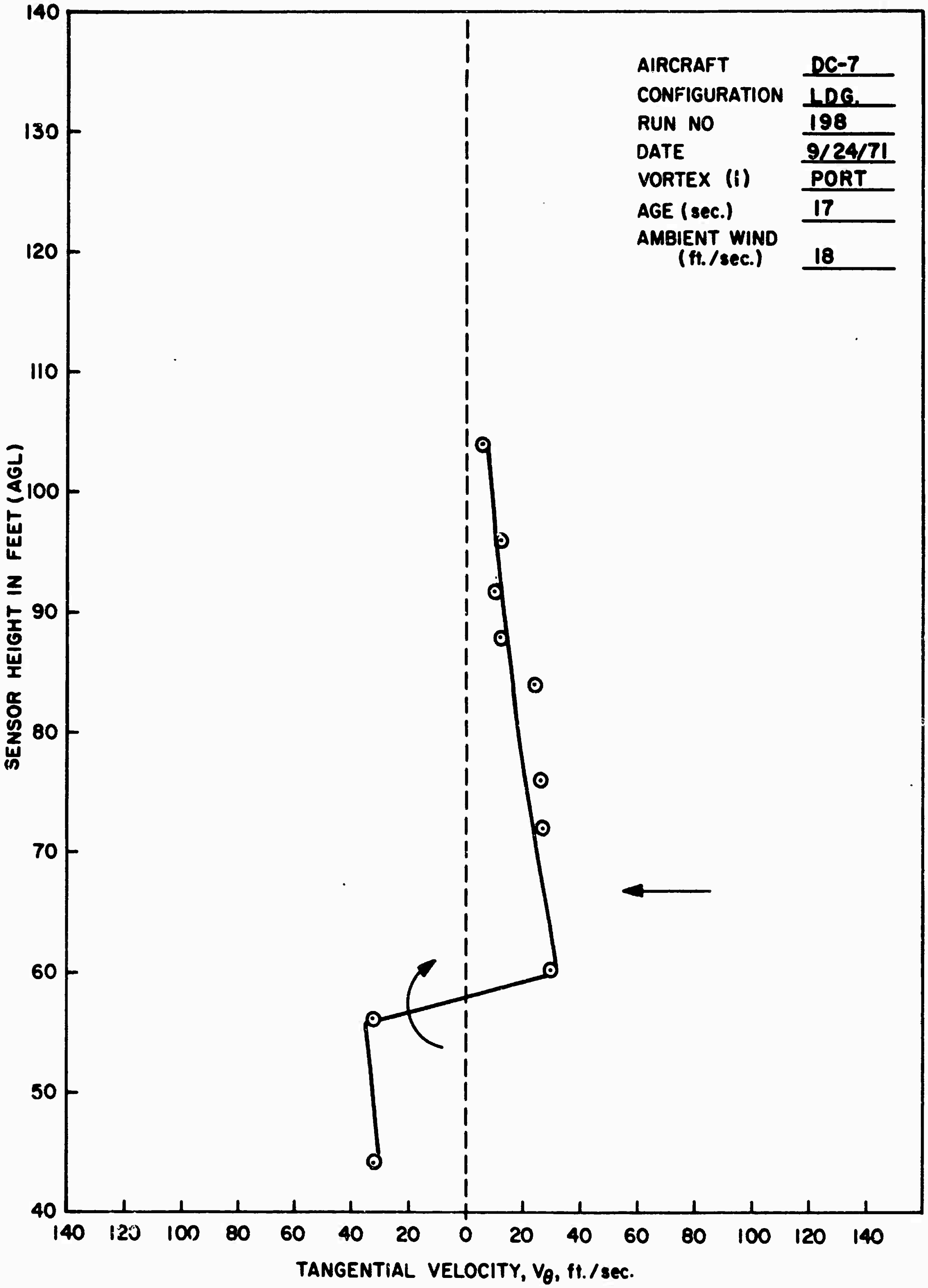


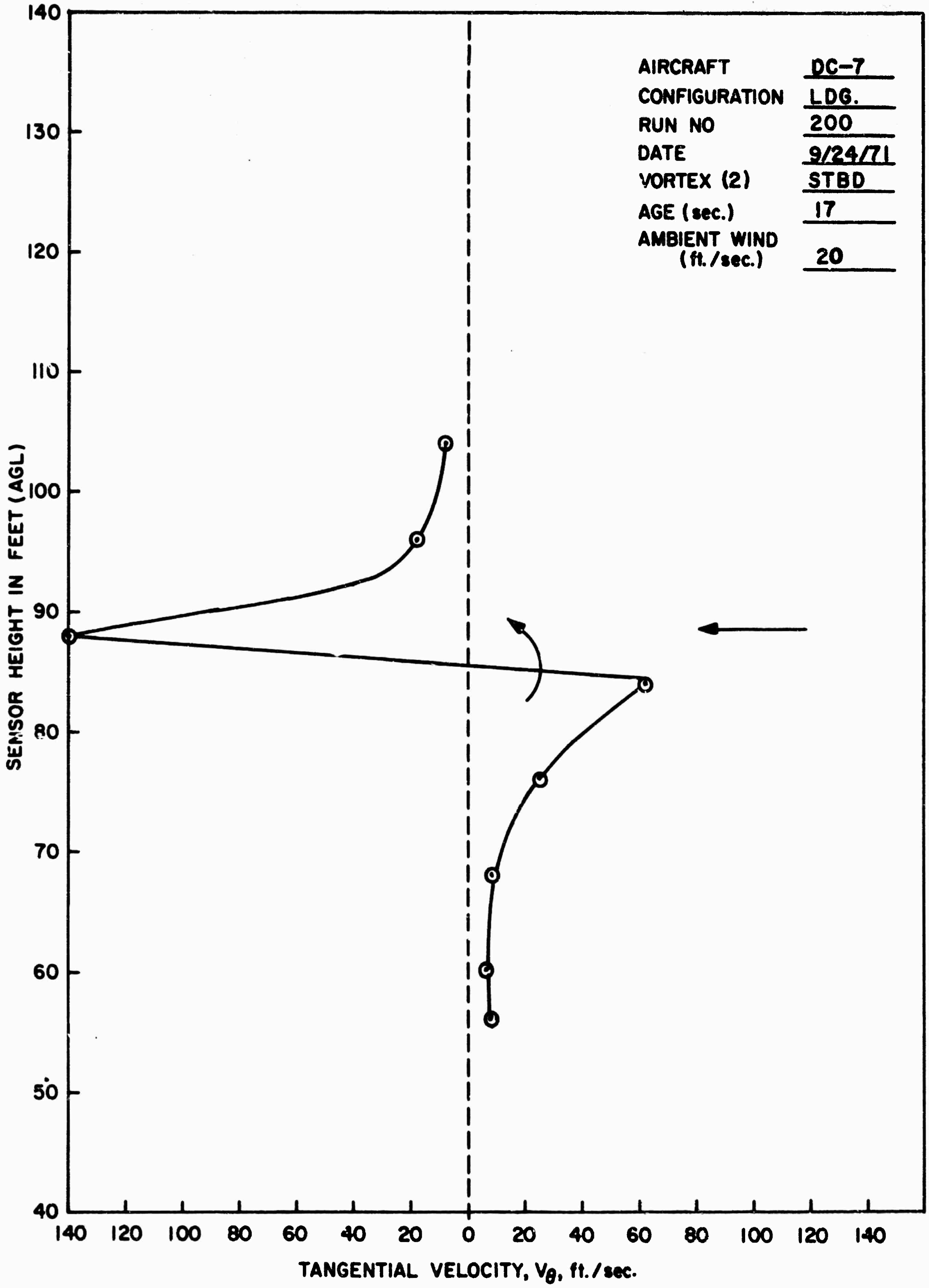
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 150
DATE 9/23/71
VORTEX (2) STBD
AGE (sec.) 17
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 194
DATE 9/24/71
VORTEX (1) PORT
AGE (sec.) 17
AMBIENT WIND (ft./sec.) 23
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

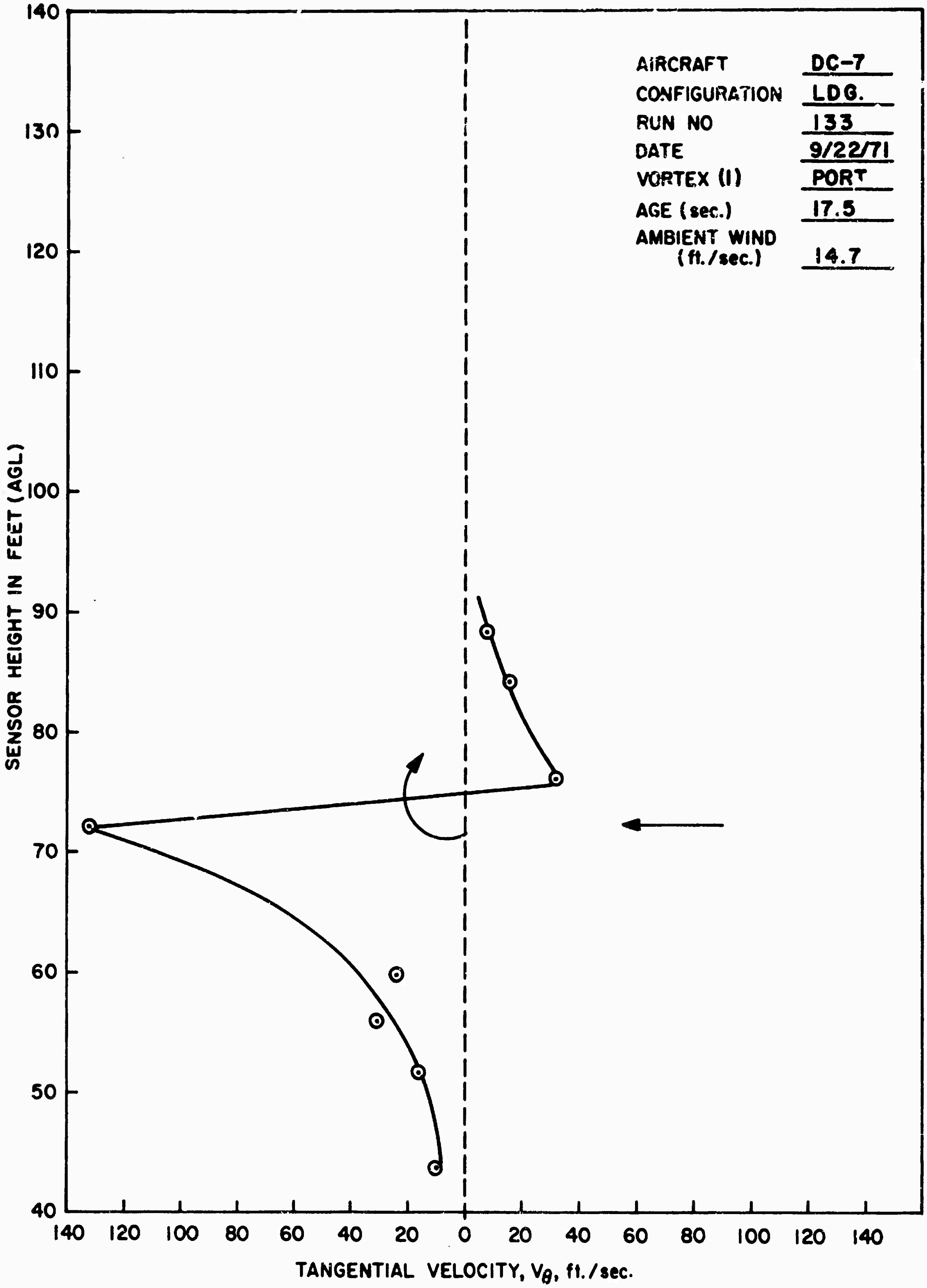


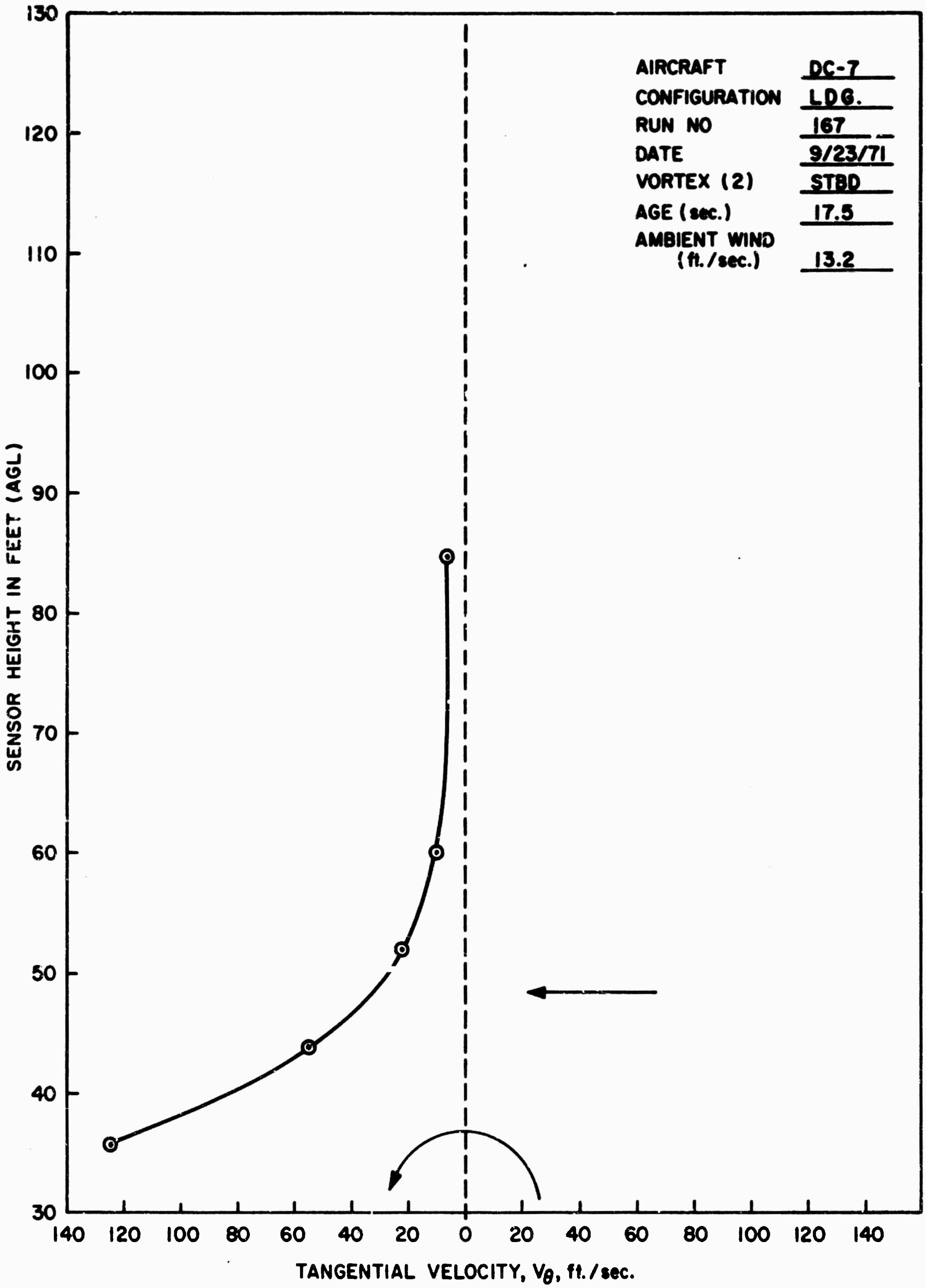
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 197
DATE 9/24/71
VORTEX (2) STBD
AGE (sec.) 17
AMBIENT WIND (ft./sec.) 18
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 198
DATE 9/24/71
VORTEX (i) PORT
AGE (sec.) 17
AMBIENT WIND (ft./sec.) 18
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

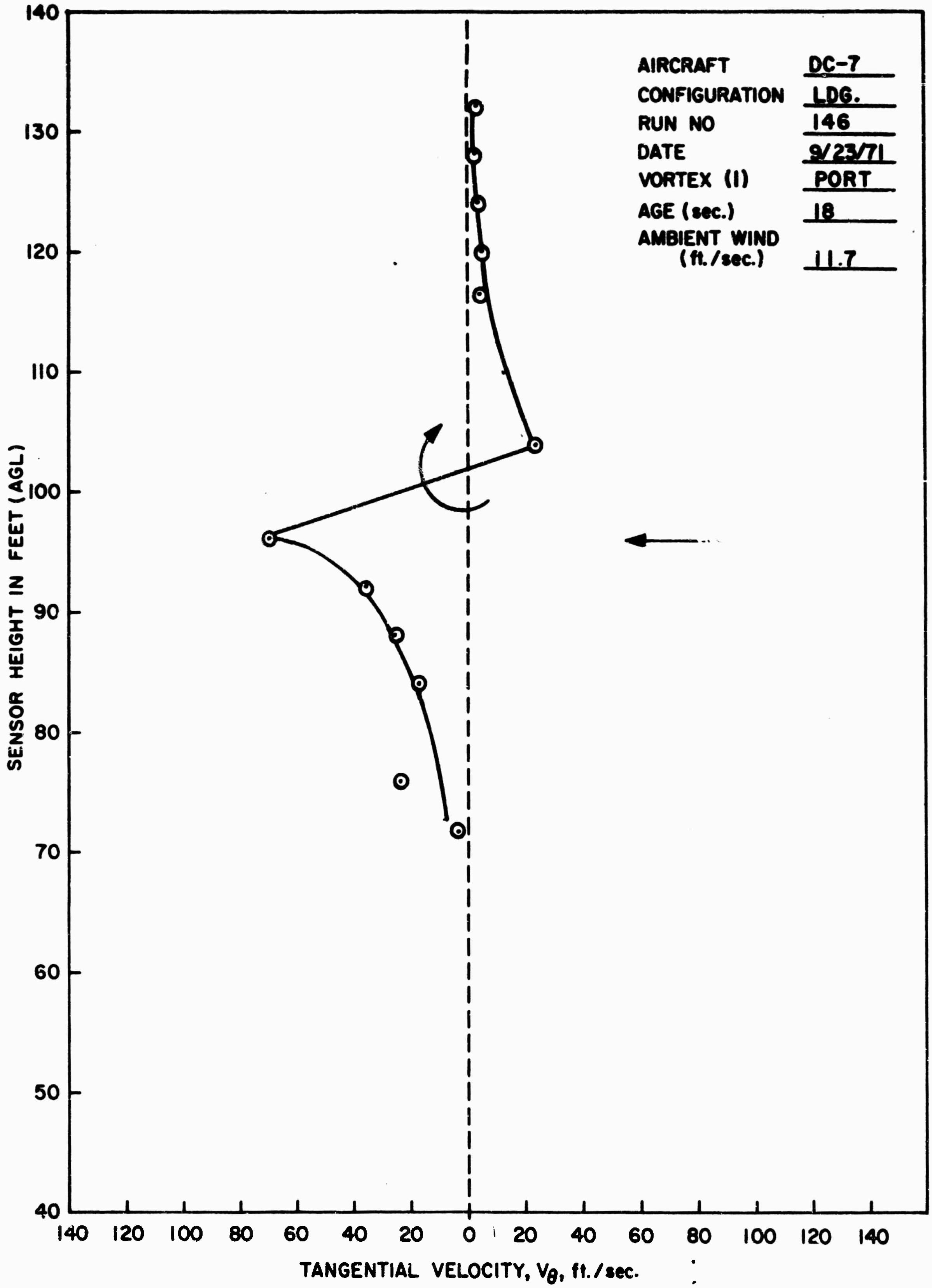


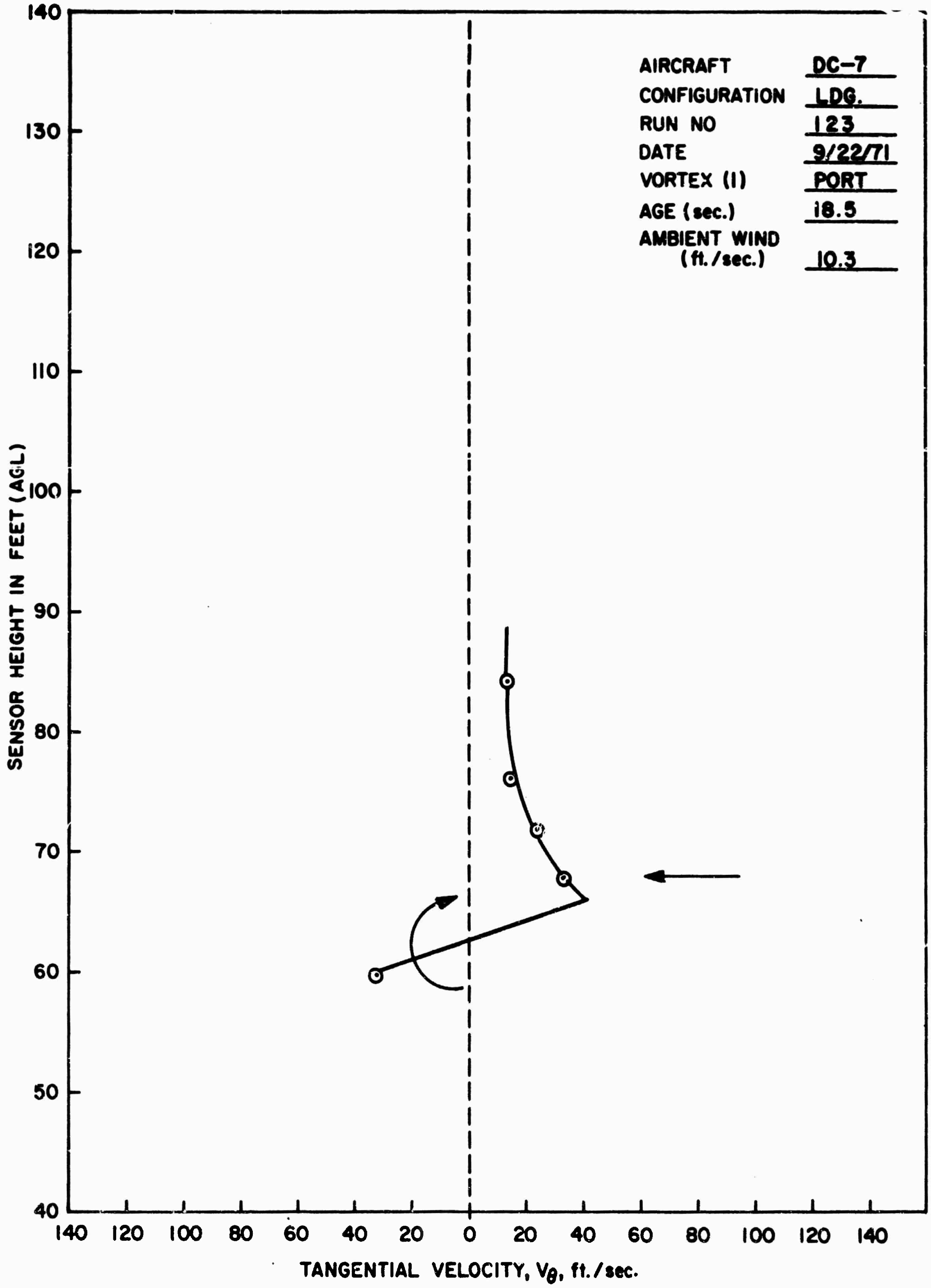
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 200
DATE 9/24/71
VORTEX (2) STBD
AGE (sec.) 17
AMBIENT WIND (ft./sec.) 20
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

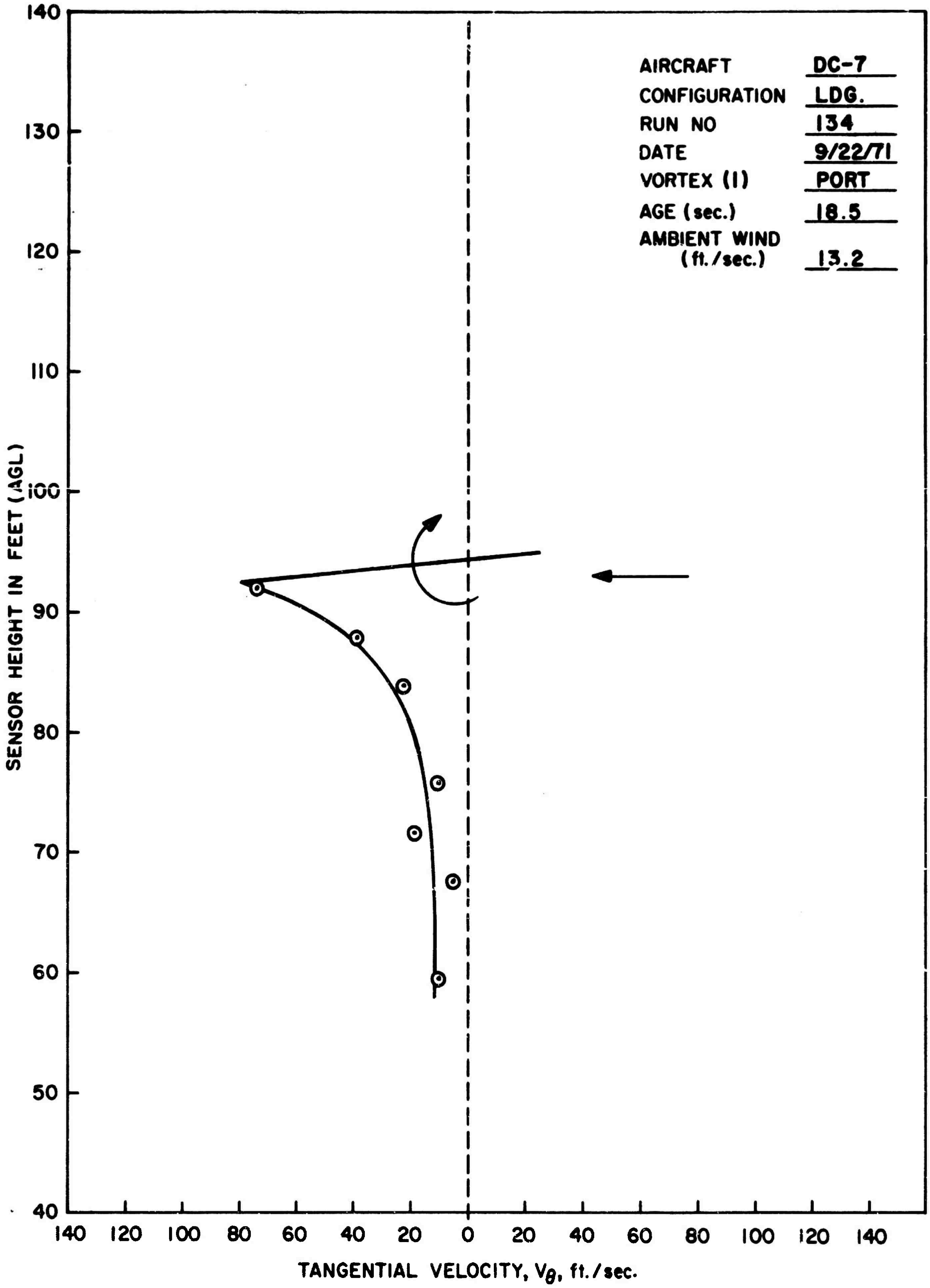

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 133
DATE 9/22/71
VORTEX (1) PORT
AGE (sec.) 17.5
AMBIENT WIND (ft./sec.) 14.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

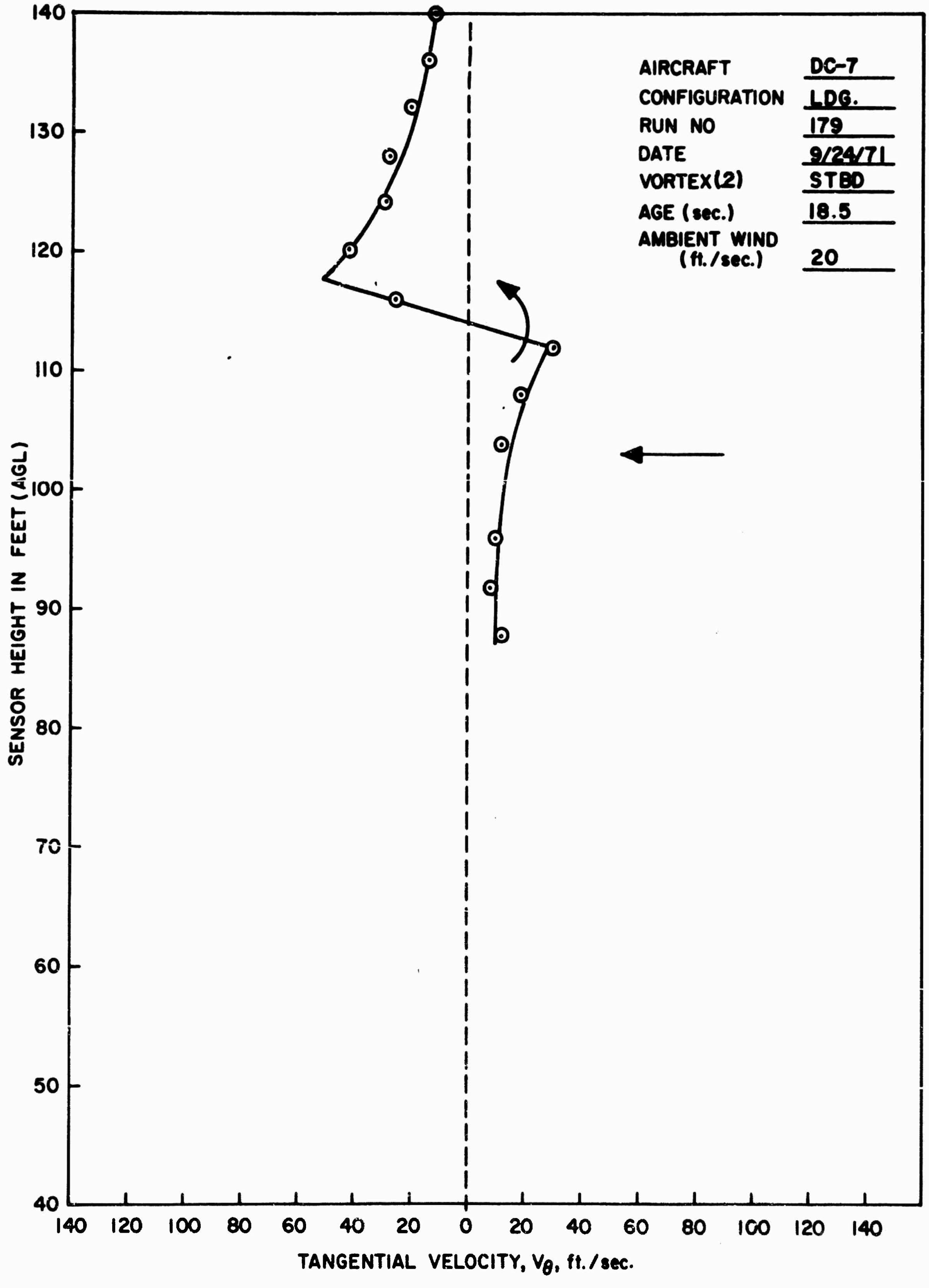


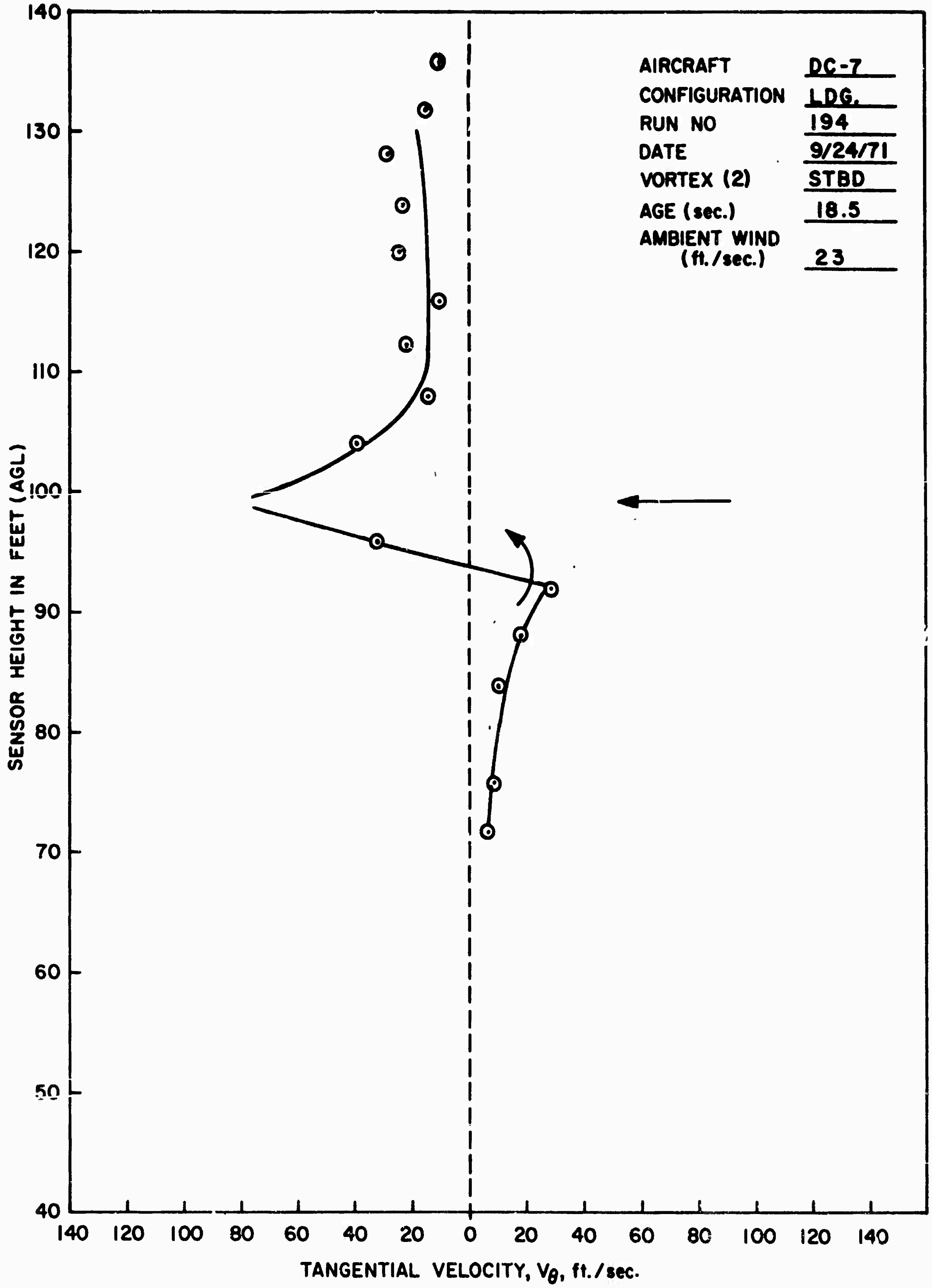
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 167
DATE 9/23/71
VORTEX (2) STBD
AGE (sec.) 17.5
AMBIENT WIND (ft./sec.) 13.2
SENSOR HEIGHT IN FEET (AGL)
130
120
110
100
90
80
70
60
50
40
30
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

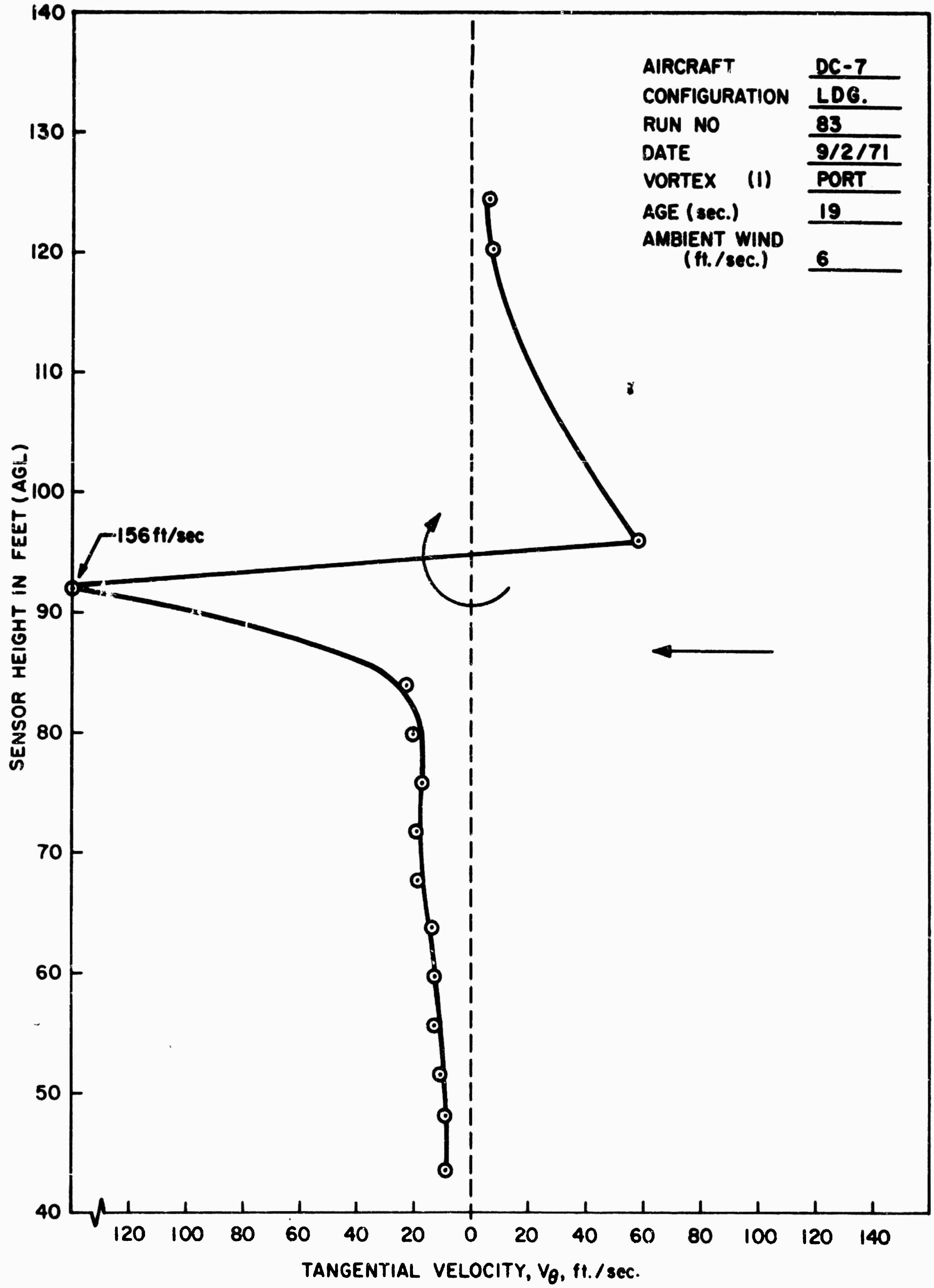

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 146
DATE 9/23/71
VORTEX (1) PORT
AGE (sec.) 18
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 123
DATE 9/22/71
VORTEX (1) PORT
AGE (sec.) 18.5
AMBIENT WIND (ft./sec.) 10.3
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

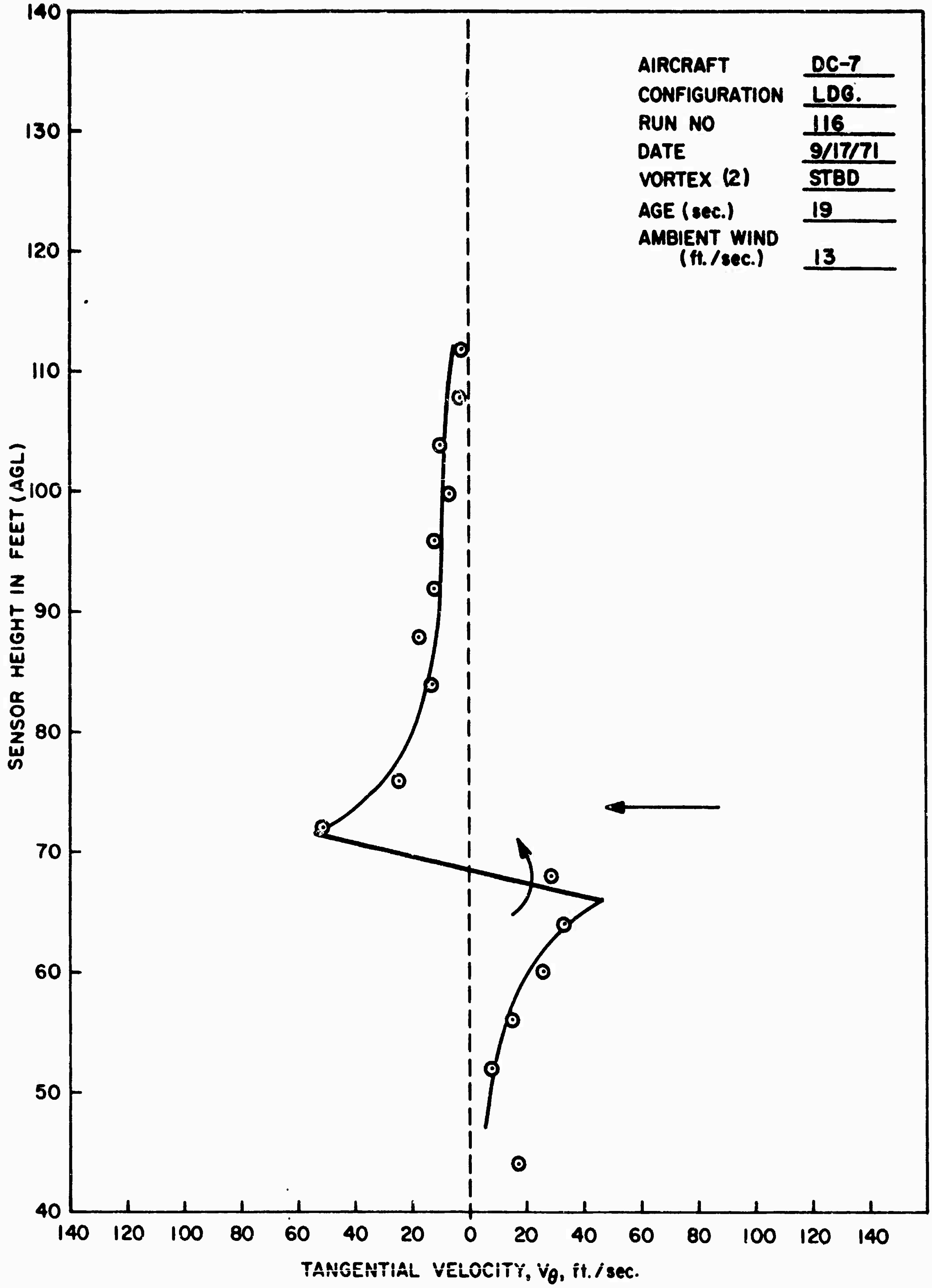

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 134
DATE 9/22/71
VORTEX (1) PORT
AGE (sec.) 18.5
AMBIENT WIND (ft./sec.) 13.2
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 179
DATE 9/24/71
VORTEX(2) STBD
AGE (sec.) 18.5
AMBIENT WIND (ft./sec.) 20
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

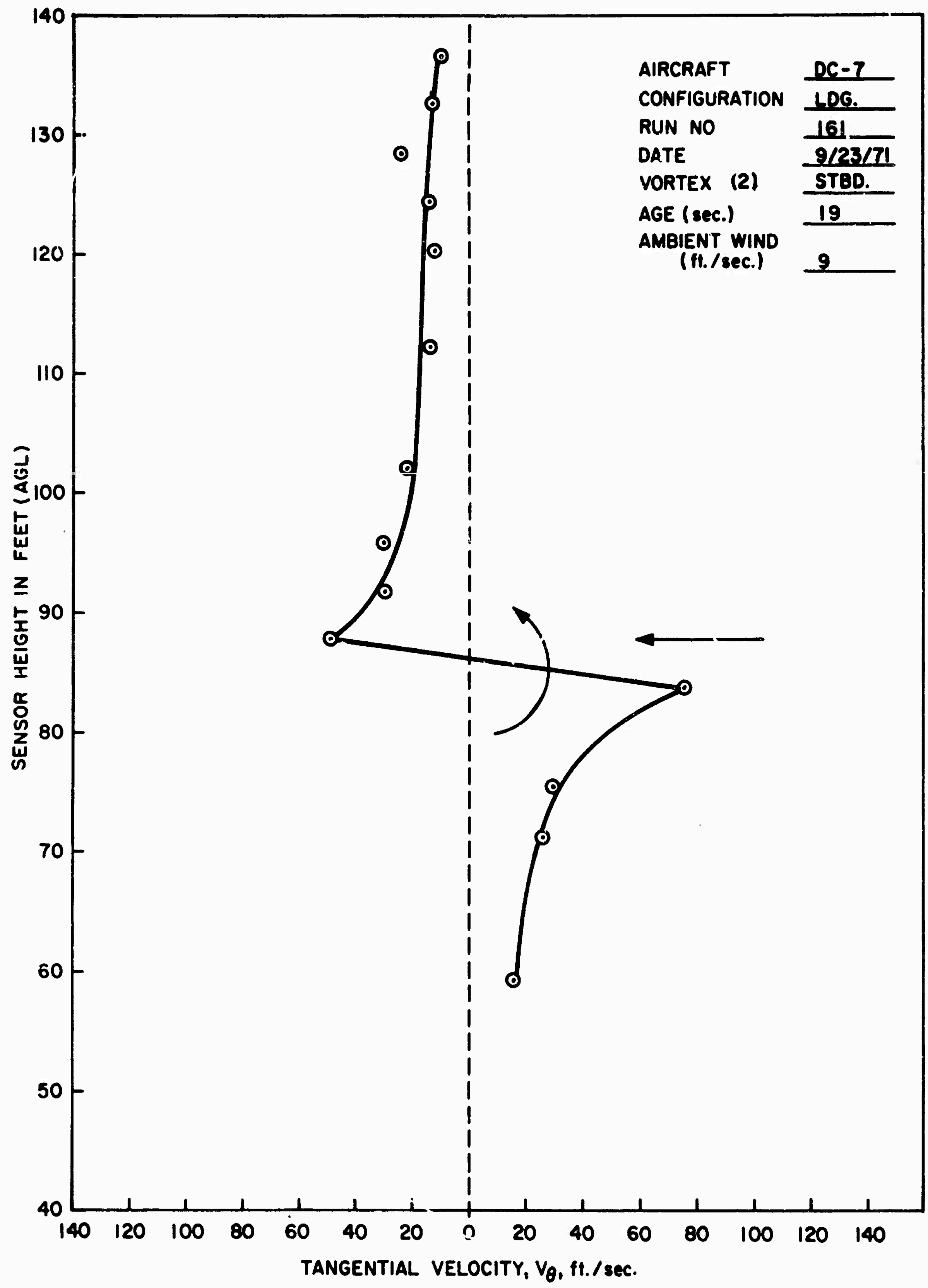

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 194
DATE 9/24/71
VORTEX (2) STBD
AGE (sec.) 18.5
AMBIENT WIND (ft./sec.) 23
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

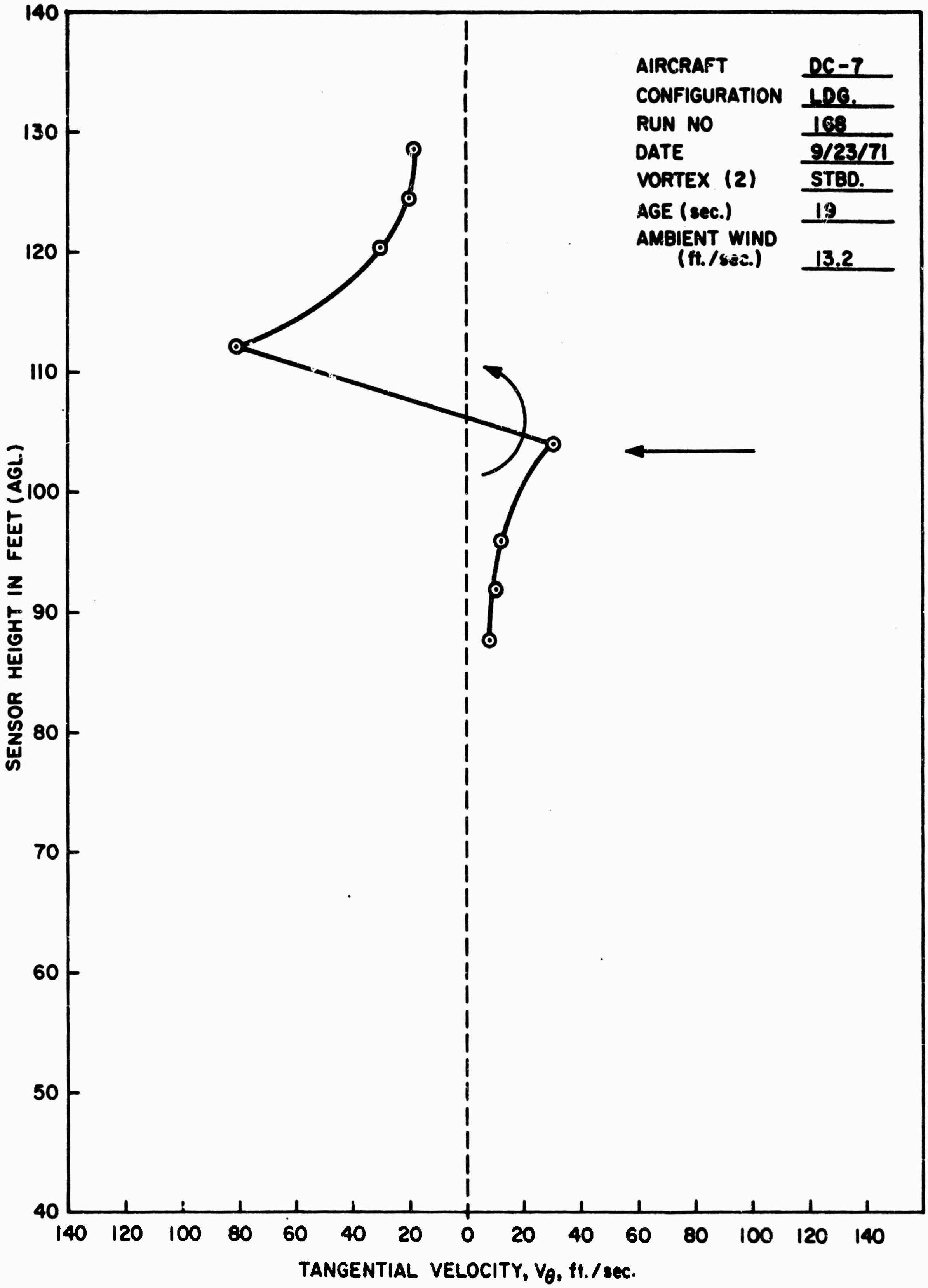


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 83
DATE 9/2/71
VORTEX (1) PORT
AGE (sec.) 19
AMBIENT WIND (ft./sec.) 6
156 ft/sec
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

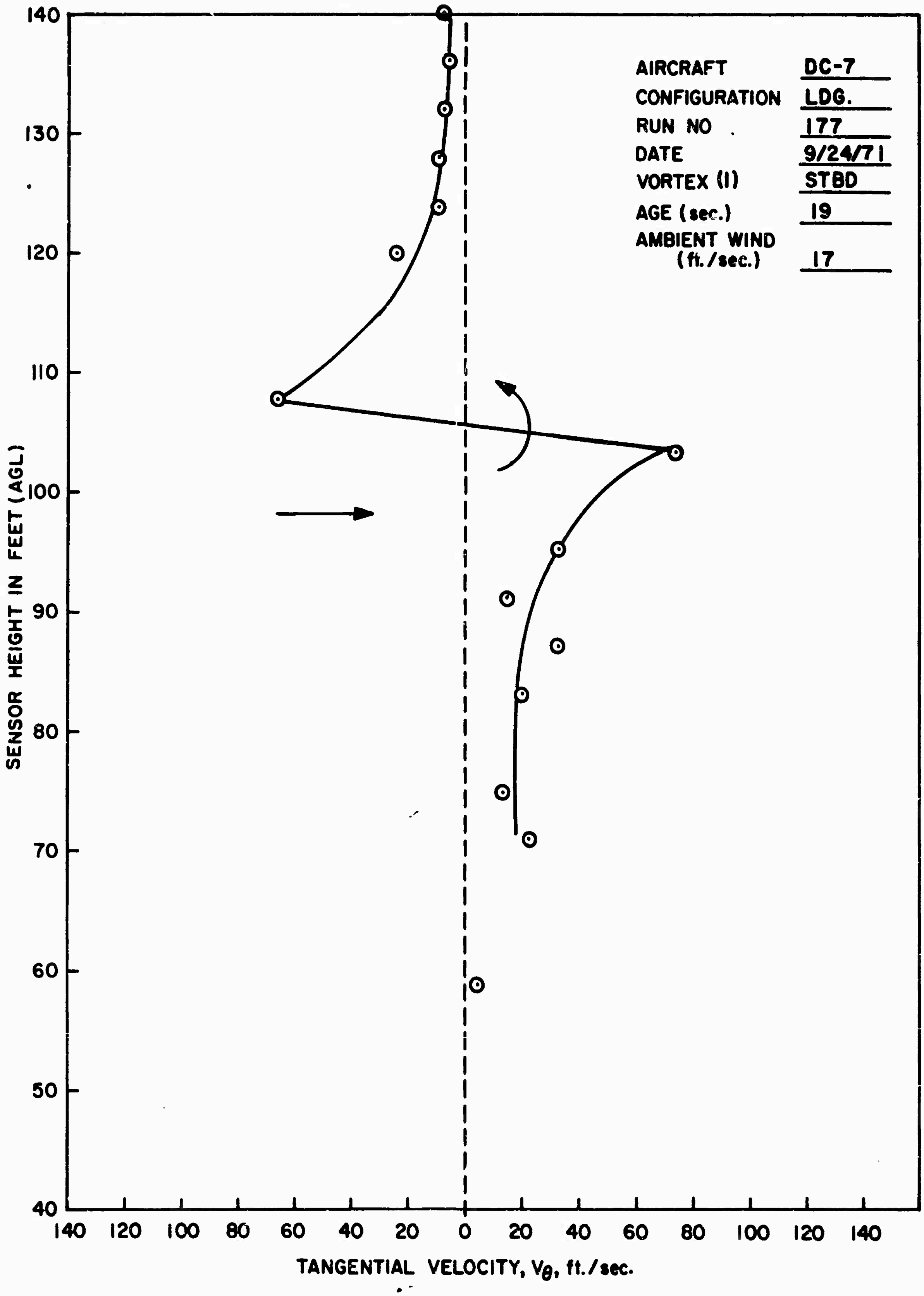


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 116
DATE 9/17/71
VORTEX (2) STBD
AGE (sec.) 19
AMBIENT WIND (ft./sec.) 13
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

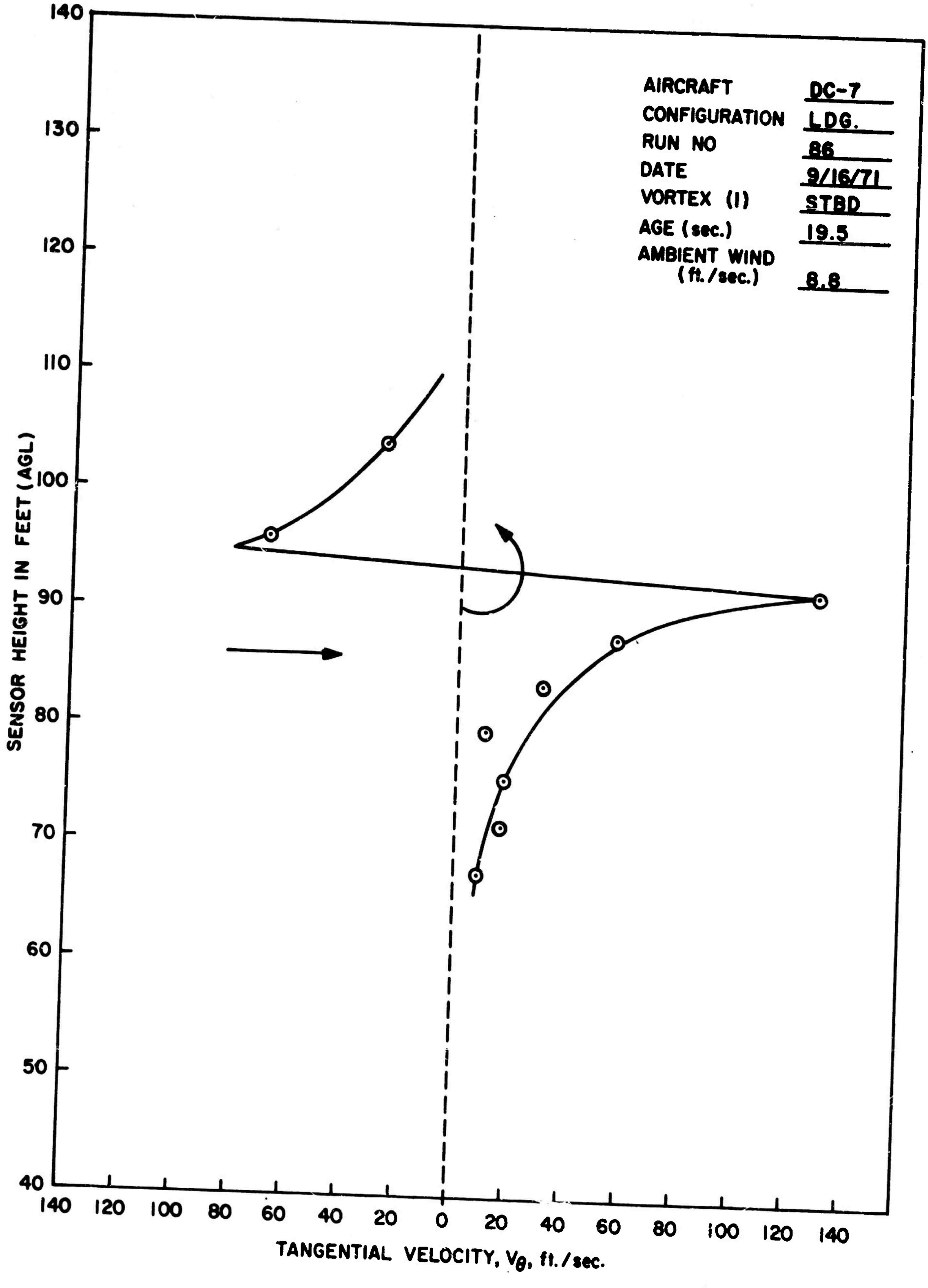

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 161
DATE 9/23/71
VORTEX (2) STBD.
AGE (sec.) 19
AMBIENT WIND (ft./sec.) 9
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



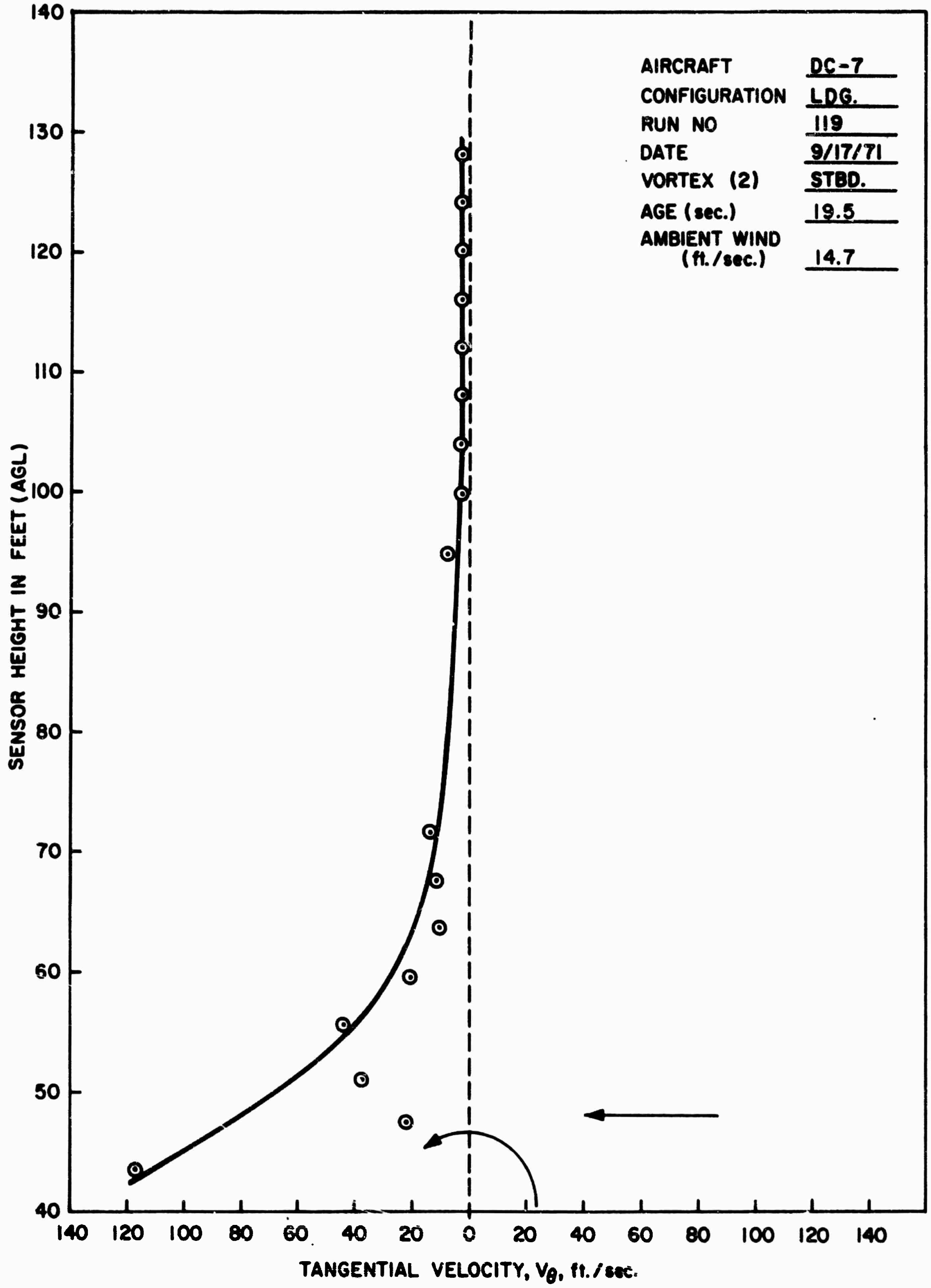
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 168
DATE 9/23/71
VORTEX (2) STBD.
AGE (sec.) 19
AMBIENT WIND (ft./sec.) 13.2
SENSOR HEIGHT IN FEET (AGL.)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

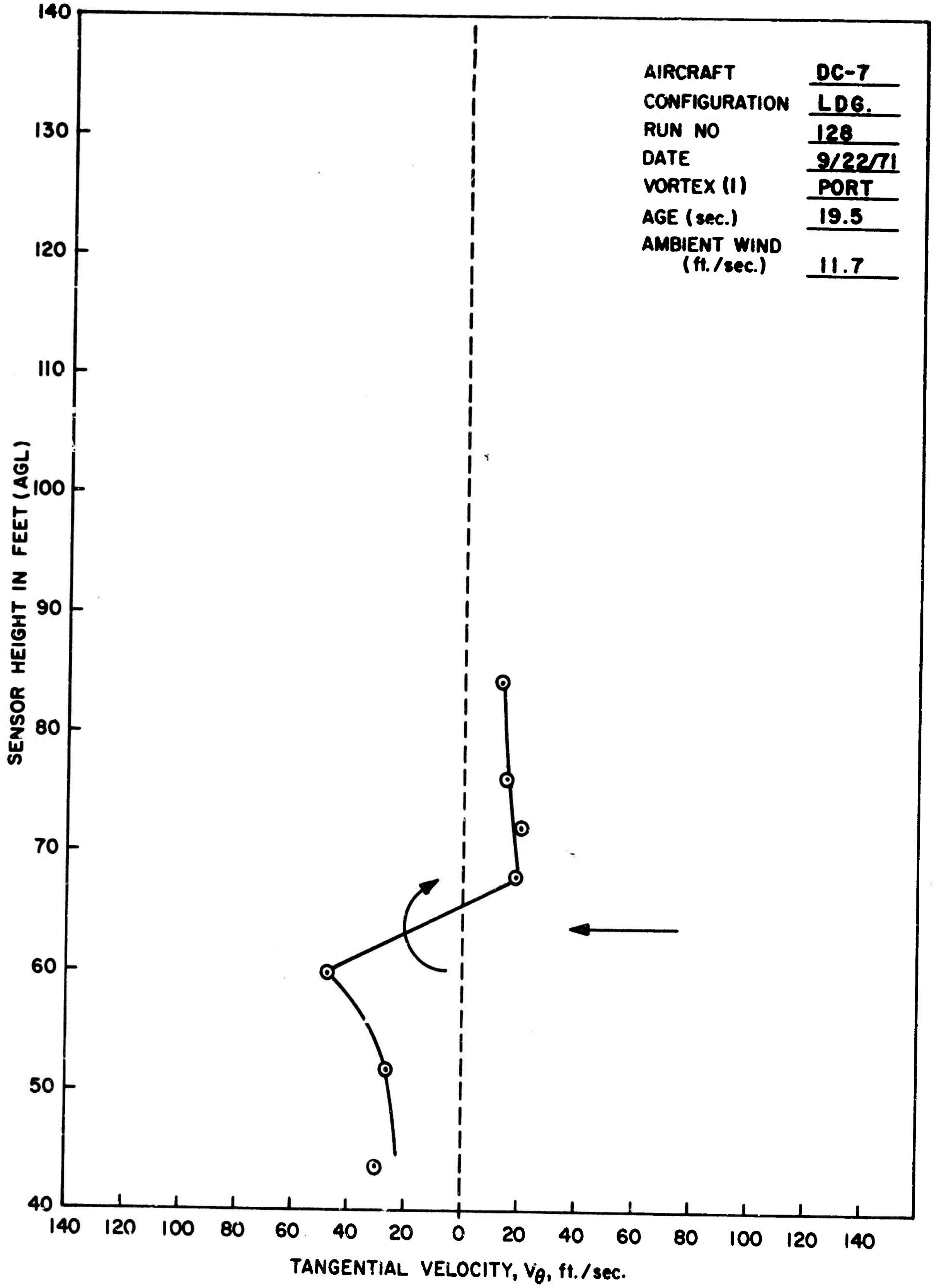


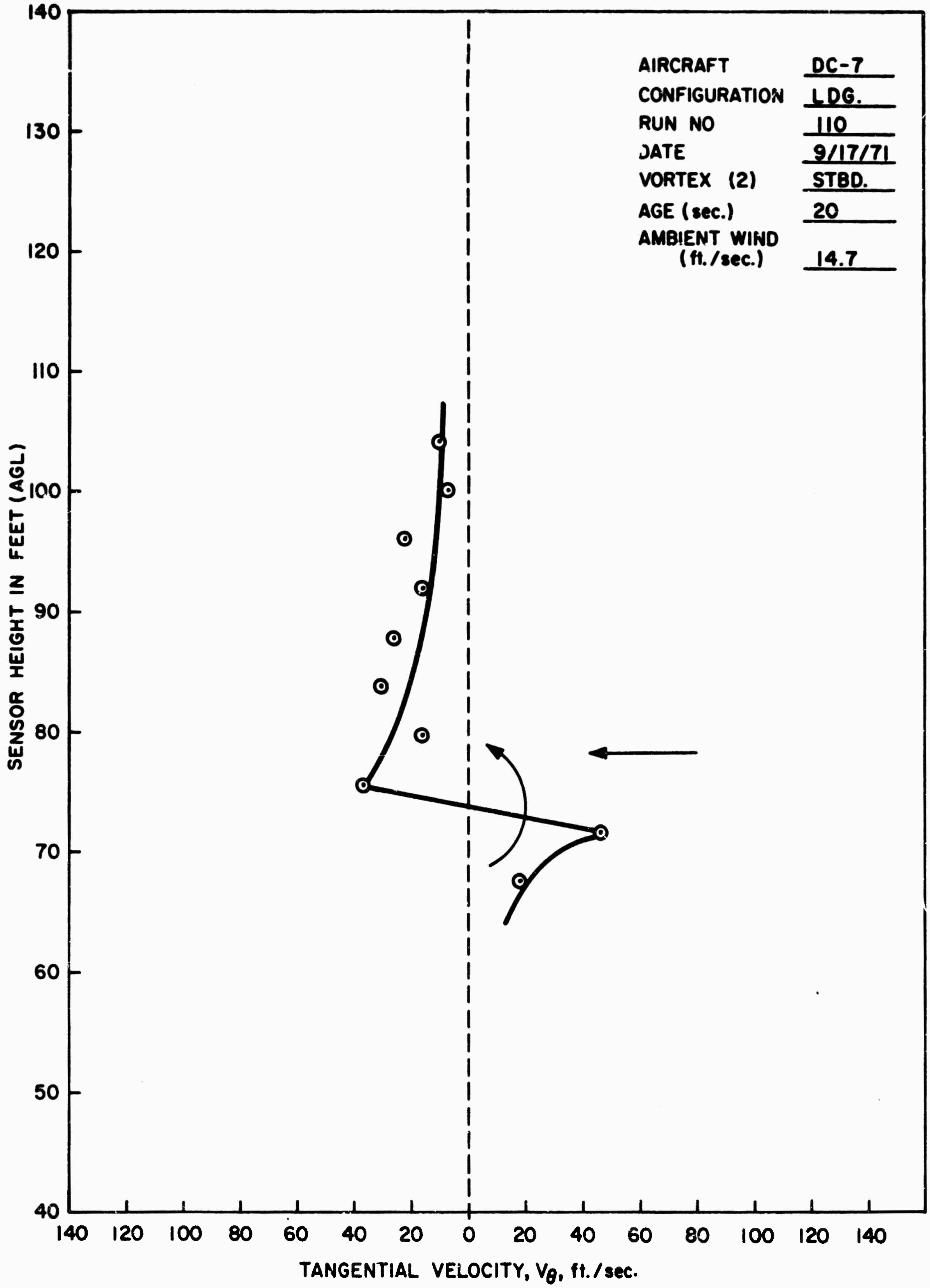
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 177
DATE 9/24/71
VORTEX (1) STBD
AGE (sec.) 19
AMBIENT WIND (ft./sec.) 17
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, Vθ, ft./sec.

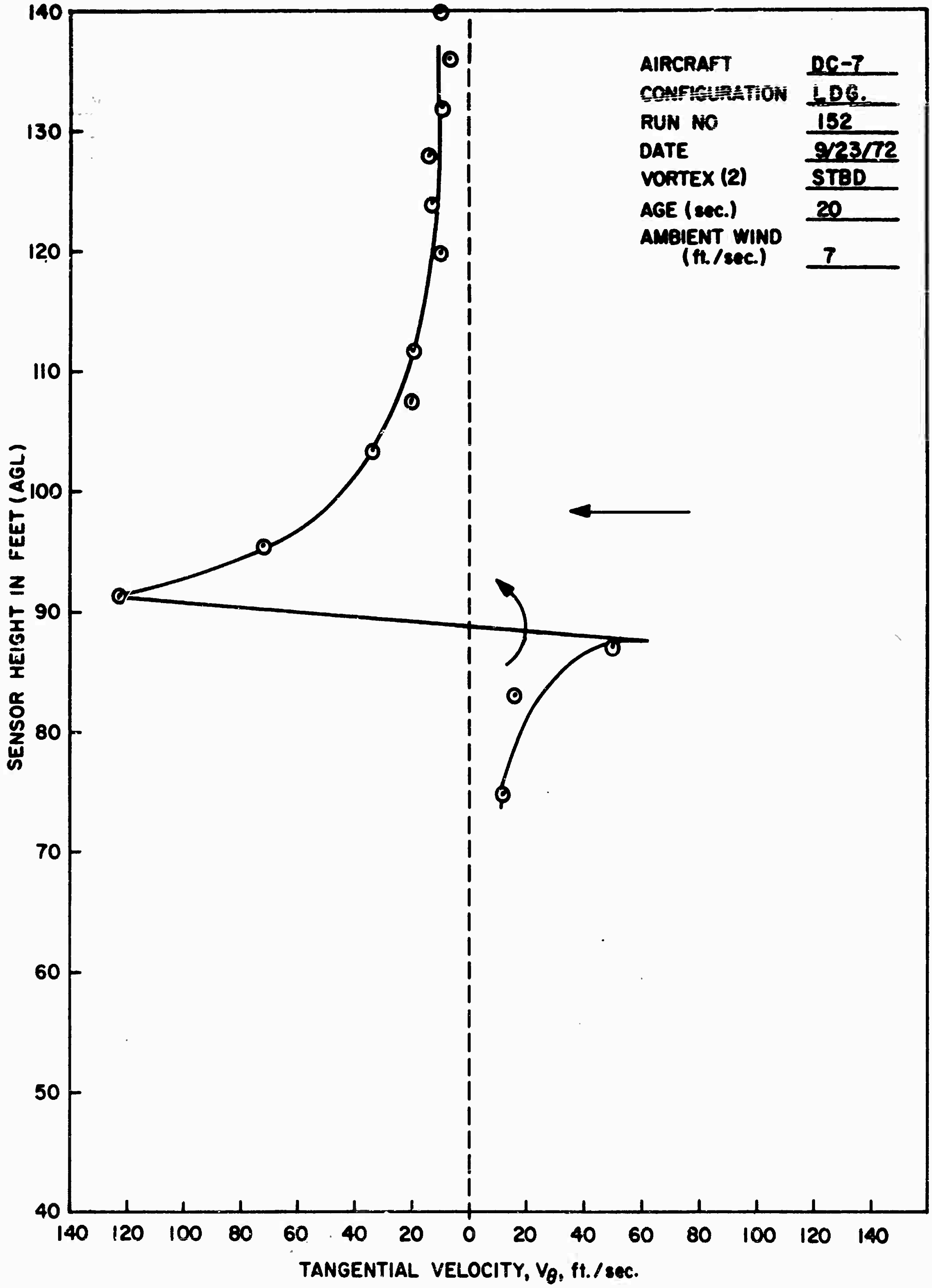


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 86
DATE 9/16/71
VORTEX (1) STBD
AGE (sec.) 19.5
AMBIENT WIND (ft./sec.) 8.8
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.

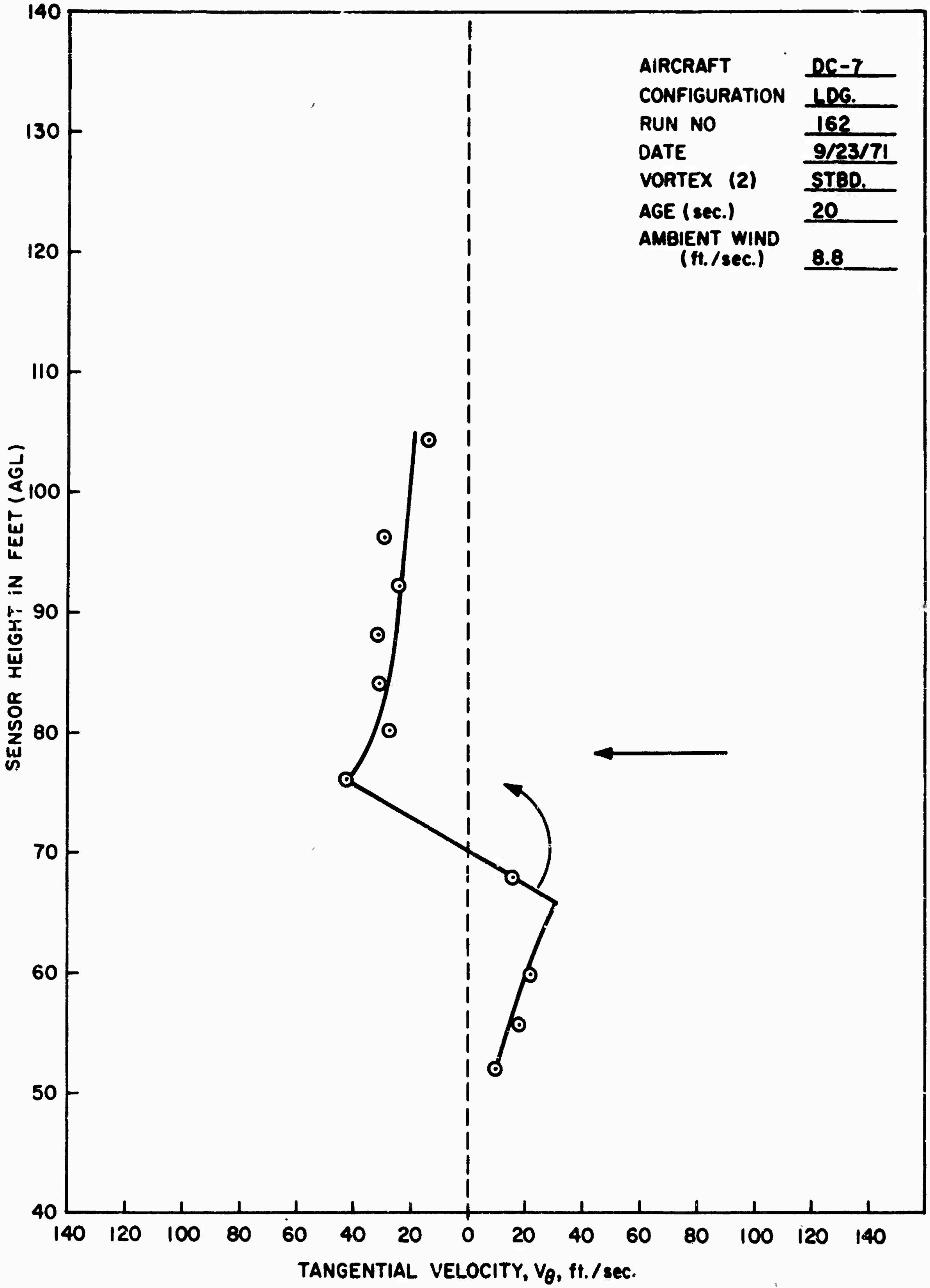

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 119
DATE 9/17/71
VORTEX (2) STBD.
AGE (sec.) 19.5
AMBIENT WIND (ft./sec.) 14.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

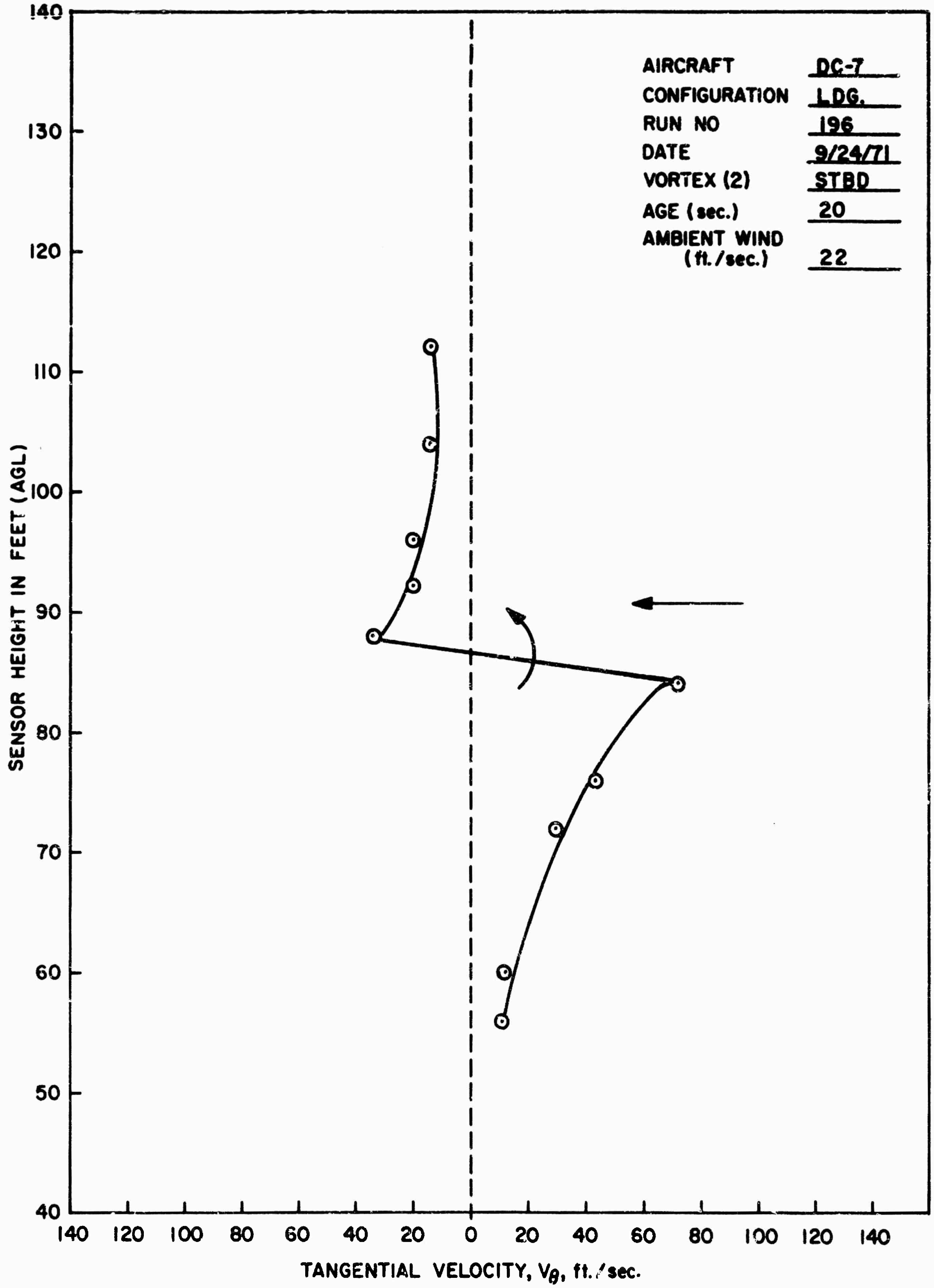

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 128
DATE 9/22/71
VORTEX (1) PORT
AGE (sec.) 19.5
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 110
DATE 9/17/71
VORTEX (2) STBD.
AGE (sec.) 20
AMBIENT WIND (ft./sec.) 14.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

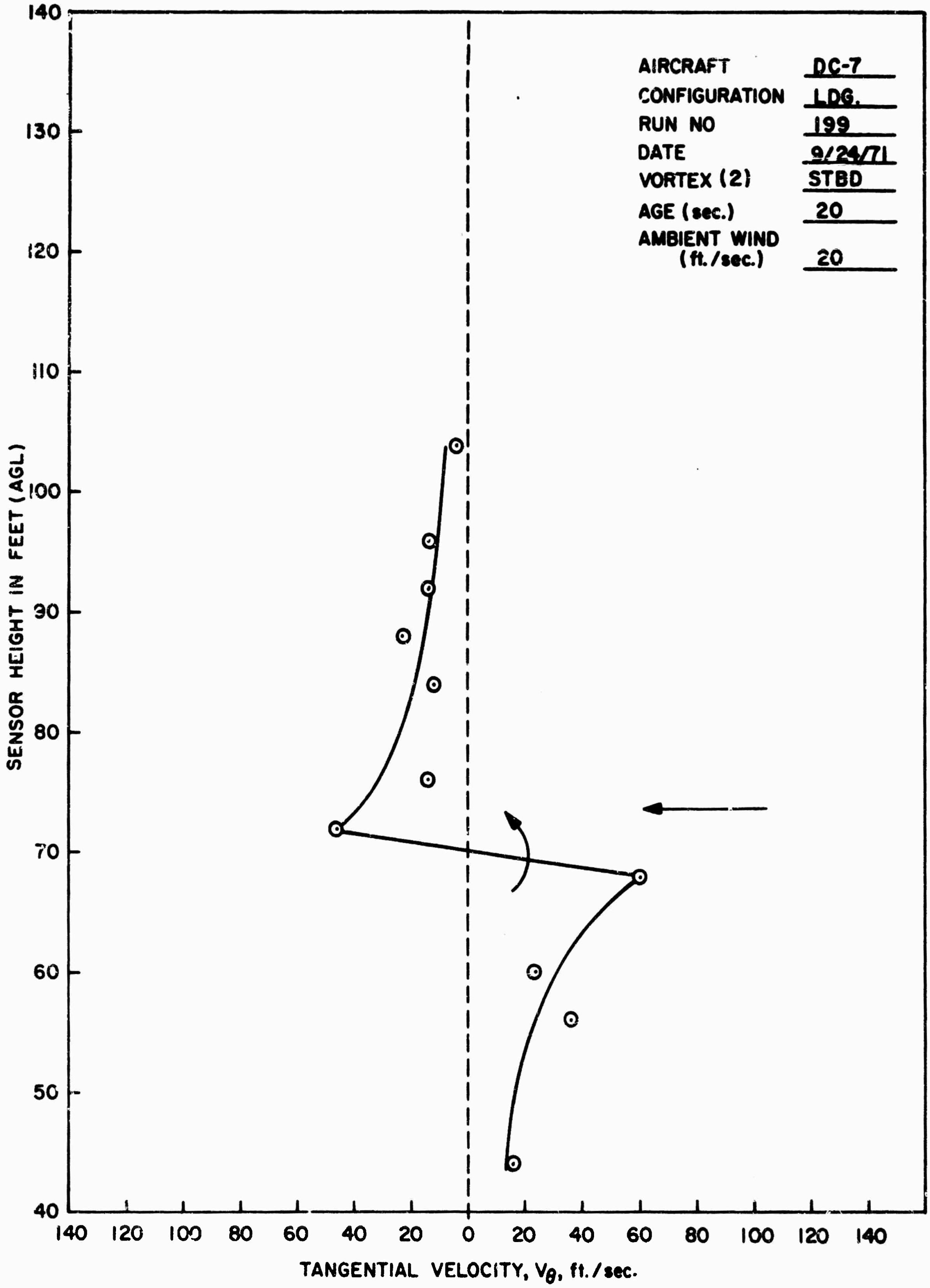


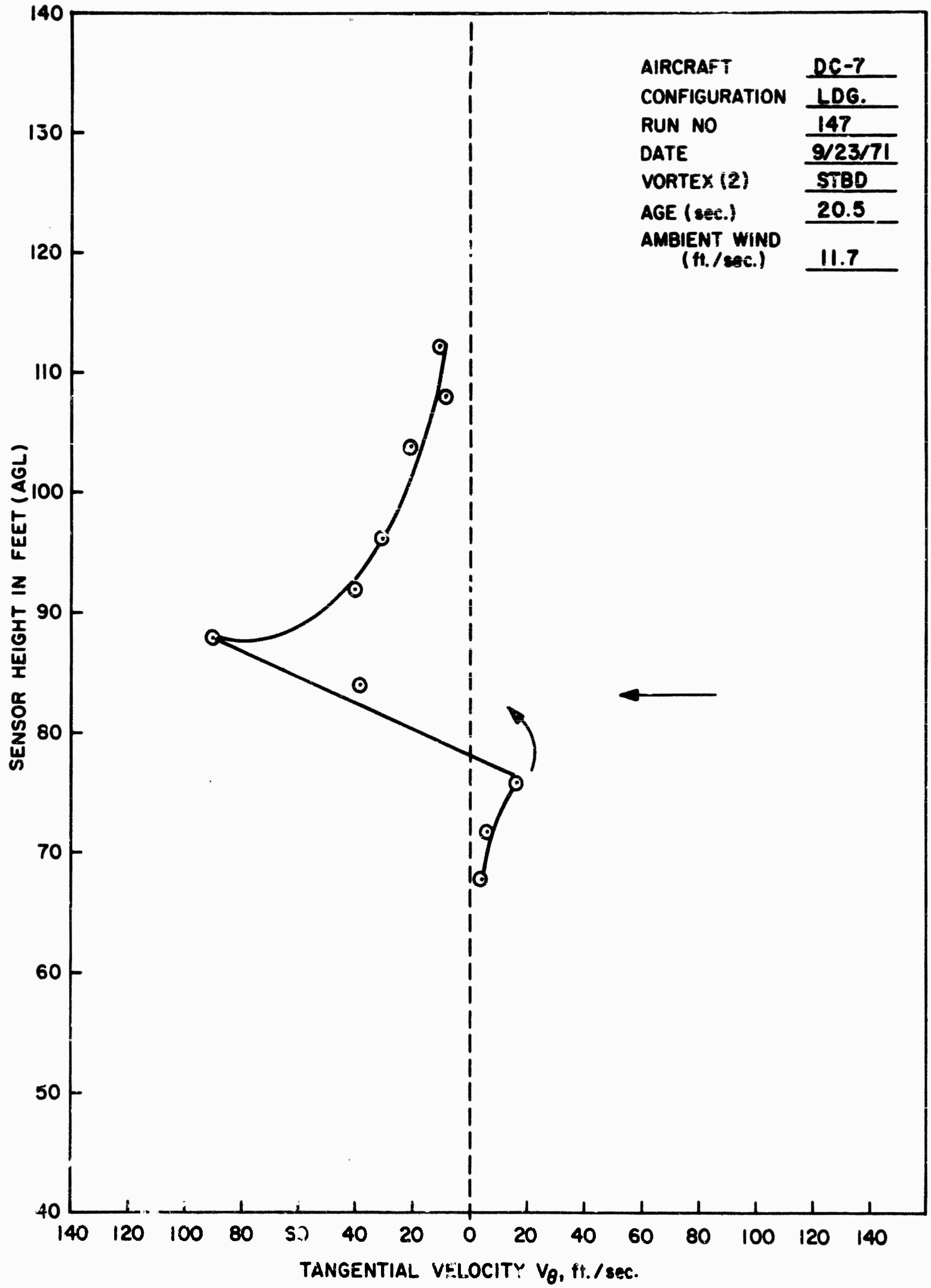
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 152
DATE 9/23/72
VORTEX (2) STBD
AGE (sec.) 20
AMBIENT WIND (ft./sec.) 7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

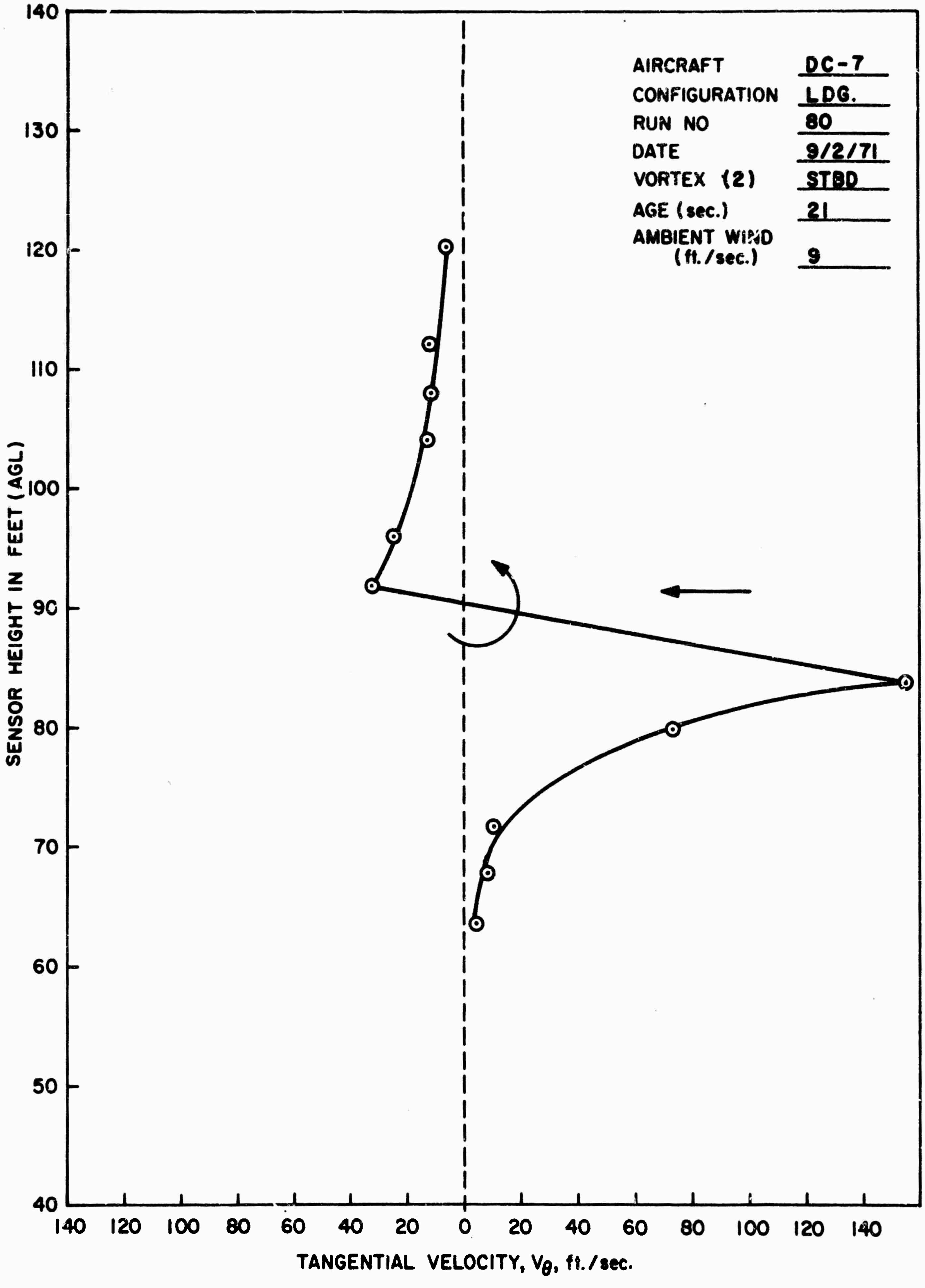

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 162
DATE 9/23/71
VORTEX (2) STBD.
AGE (sec.) 20
AMBIENT WIND (ft./sec.) 8.8
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, Vθ, ft./sec.

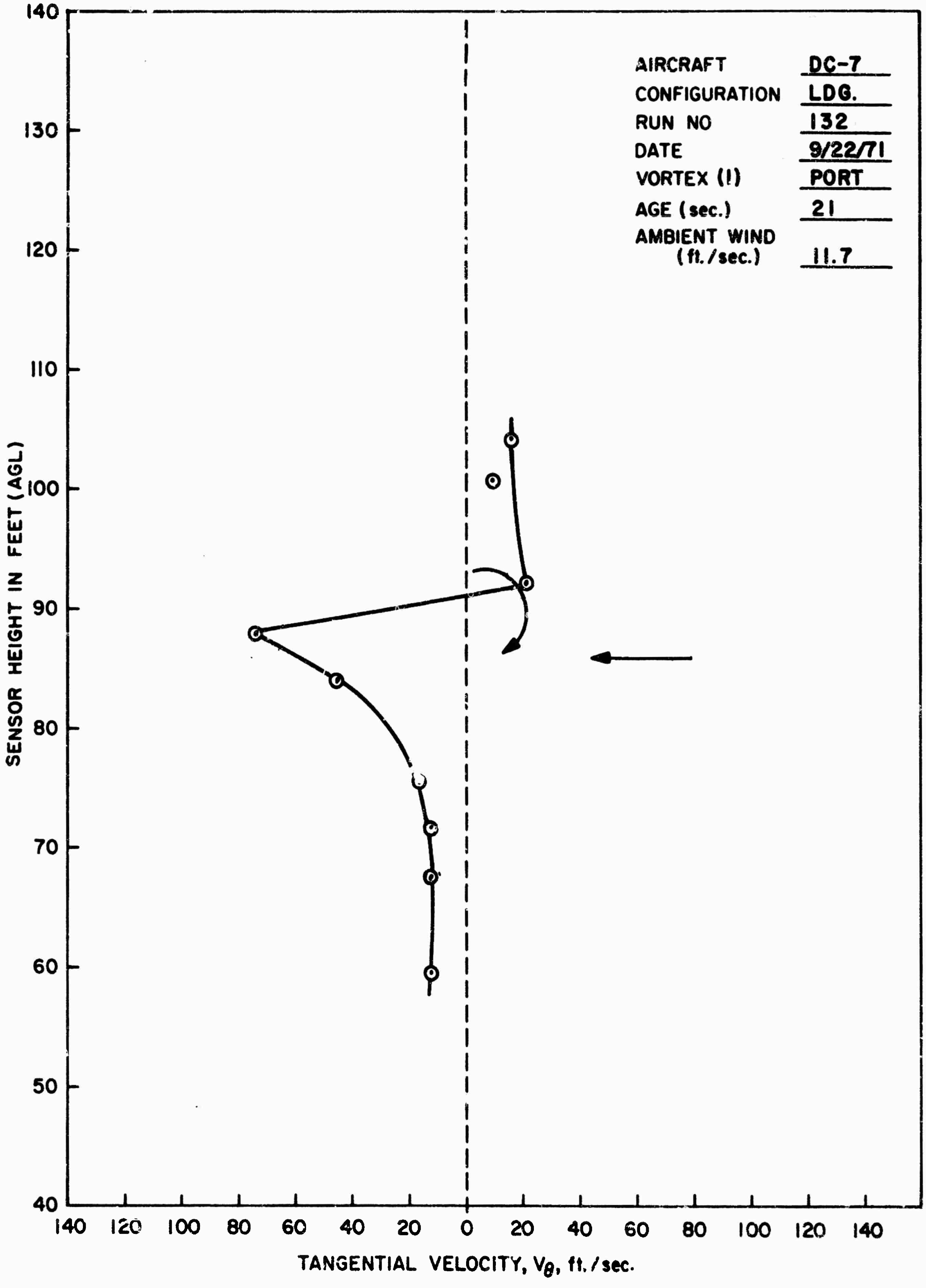


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 196
DATE 9/24/71
VORTEX (2) STBD
AGE (sec.) 20
AMBIENT WIND (ft./sec.) 22
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

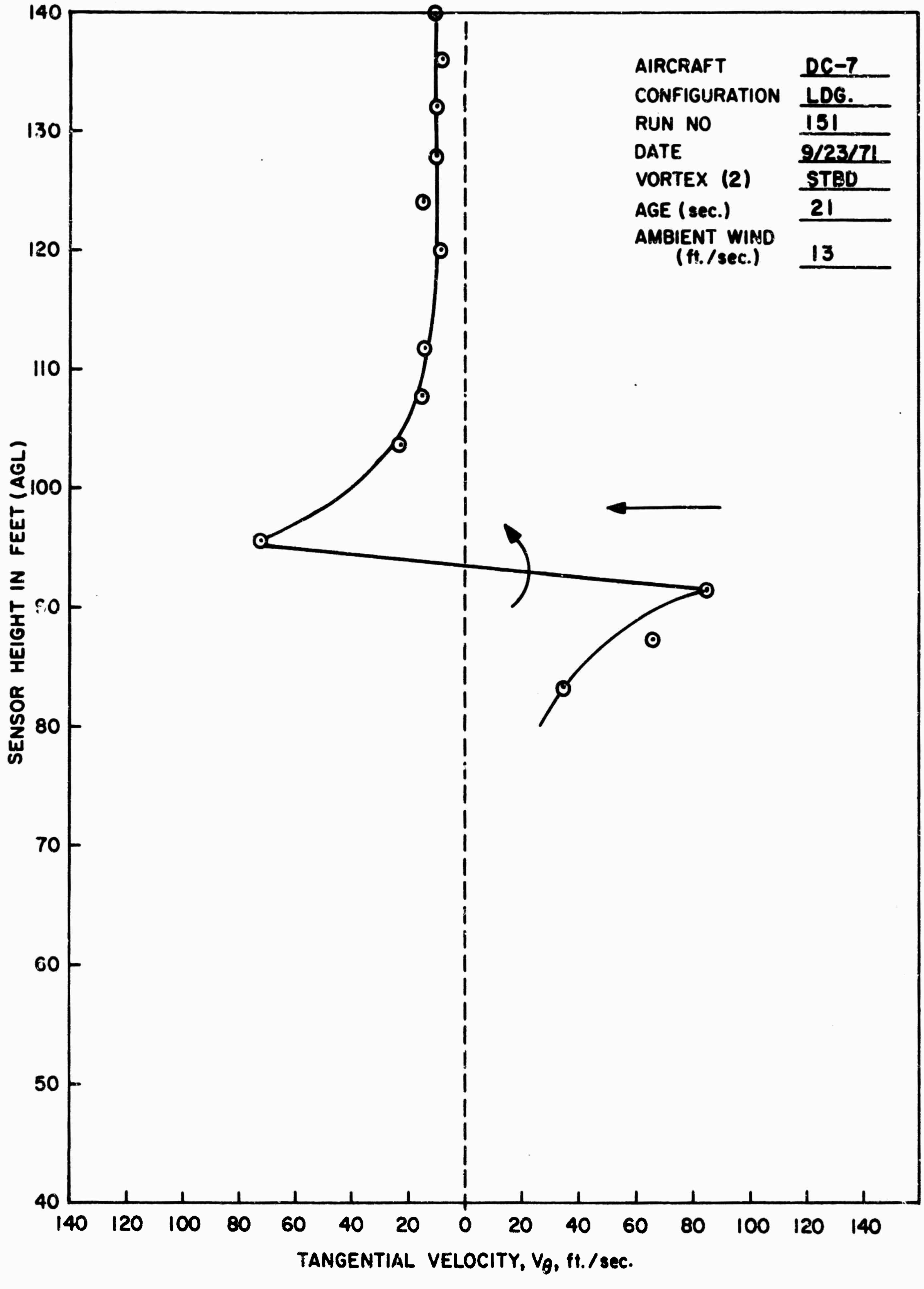

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 199
DATE 9/24/71
VORTEX (2) STBD
AGE (sec.) 20
AMBIENT WIND (ft./sec.) 20
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 147
DATE 9/23/71
VORTEX (2) STBD
AGE (sec.) 20.5
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY V_θ, ft./sec.

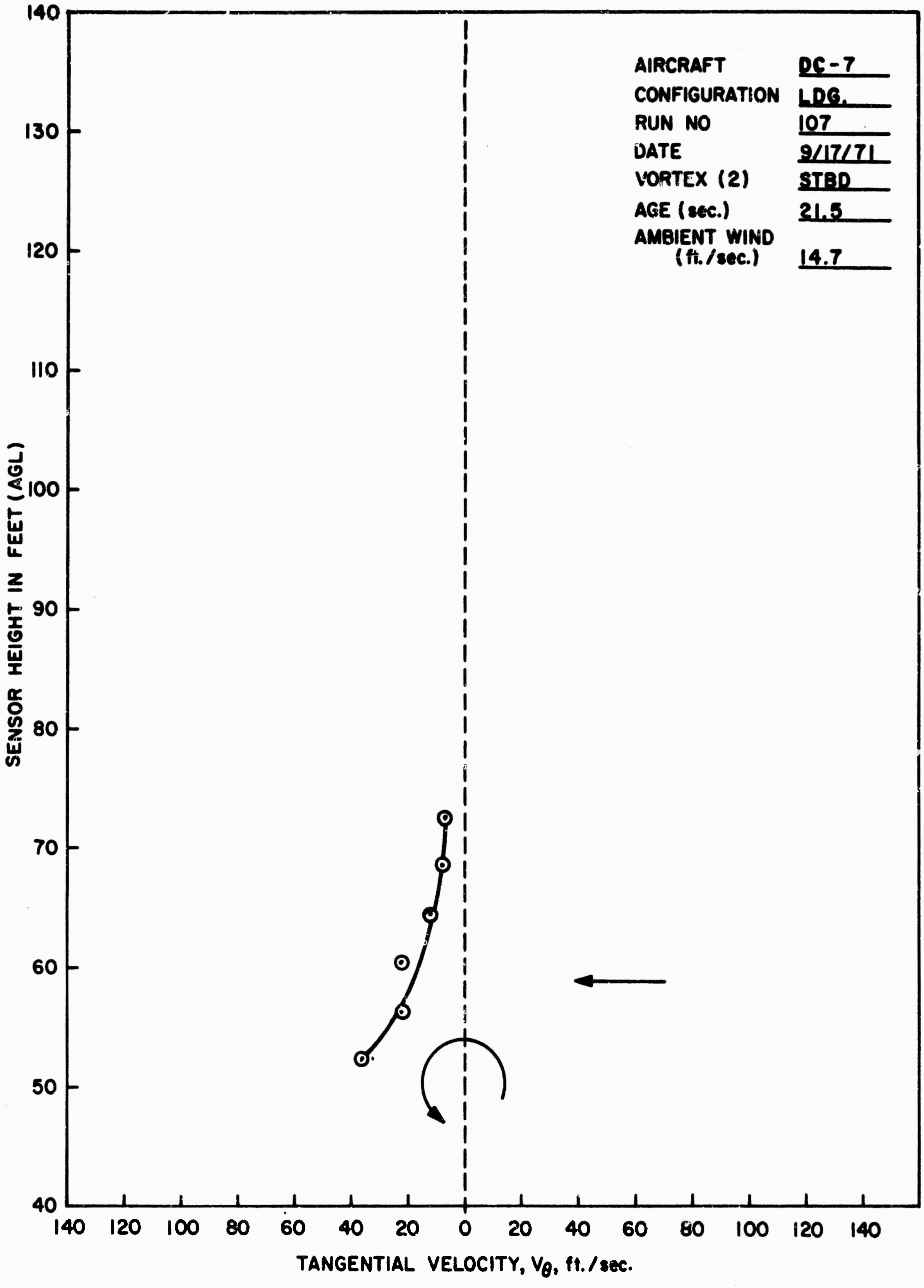

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 80
DATE 9/2/71
VORTEX (2) STBD
AGE (sec.) 21
AMBIENT WIND (ft./sec.) 9
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



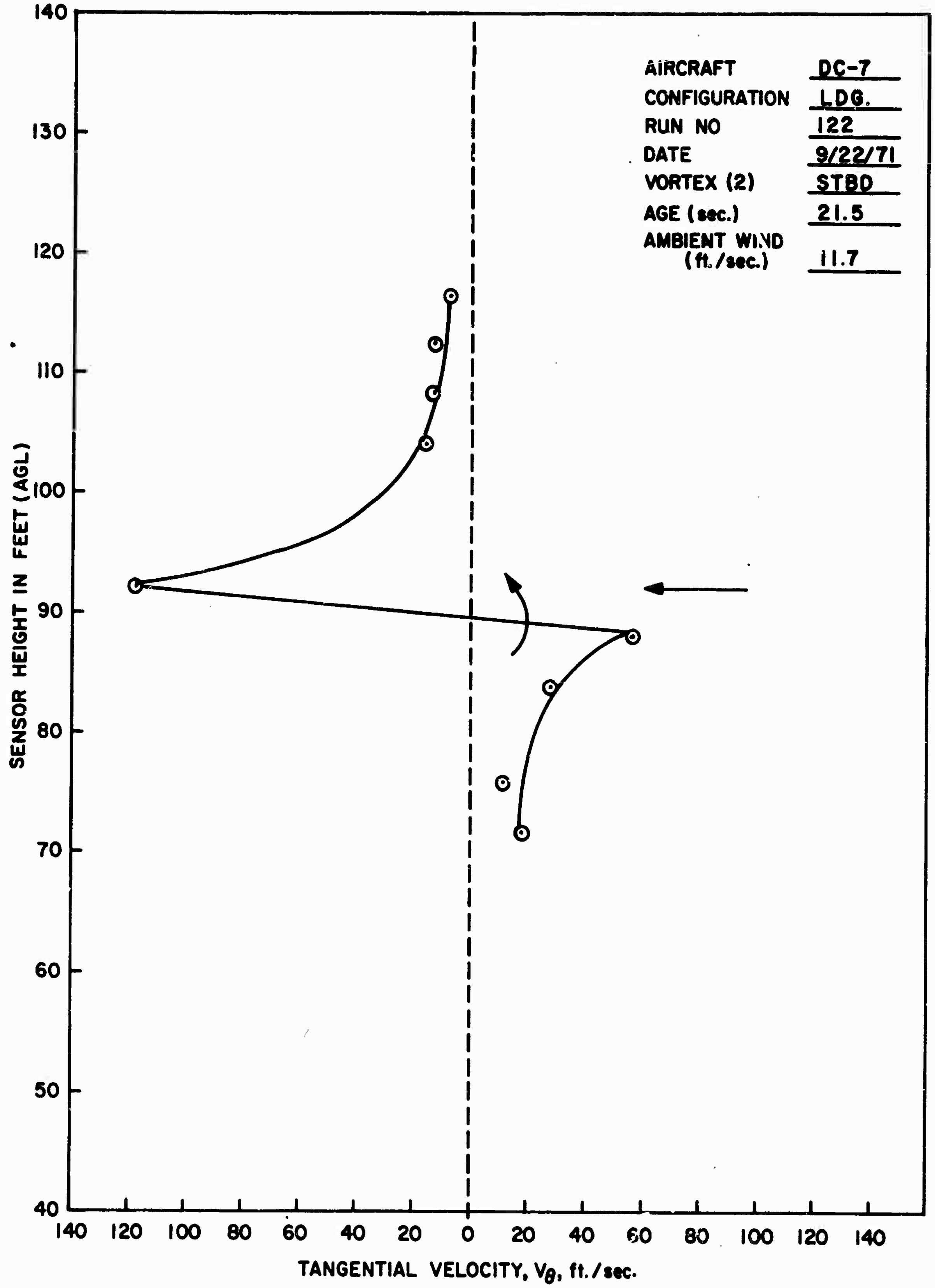
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 132
DATE 9/22/71
VORTEX (1) PORT
AGE (sec.) 21
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140



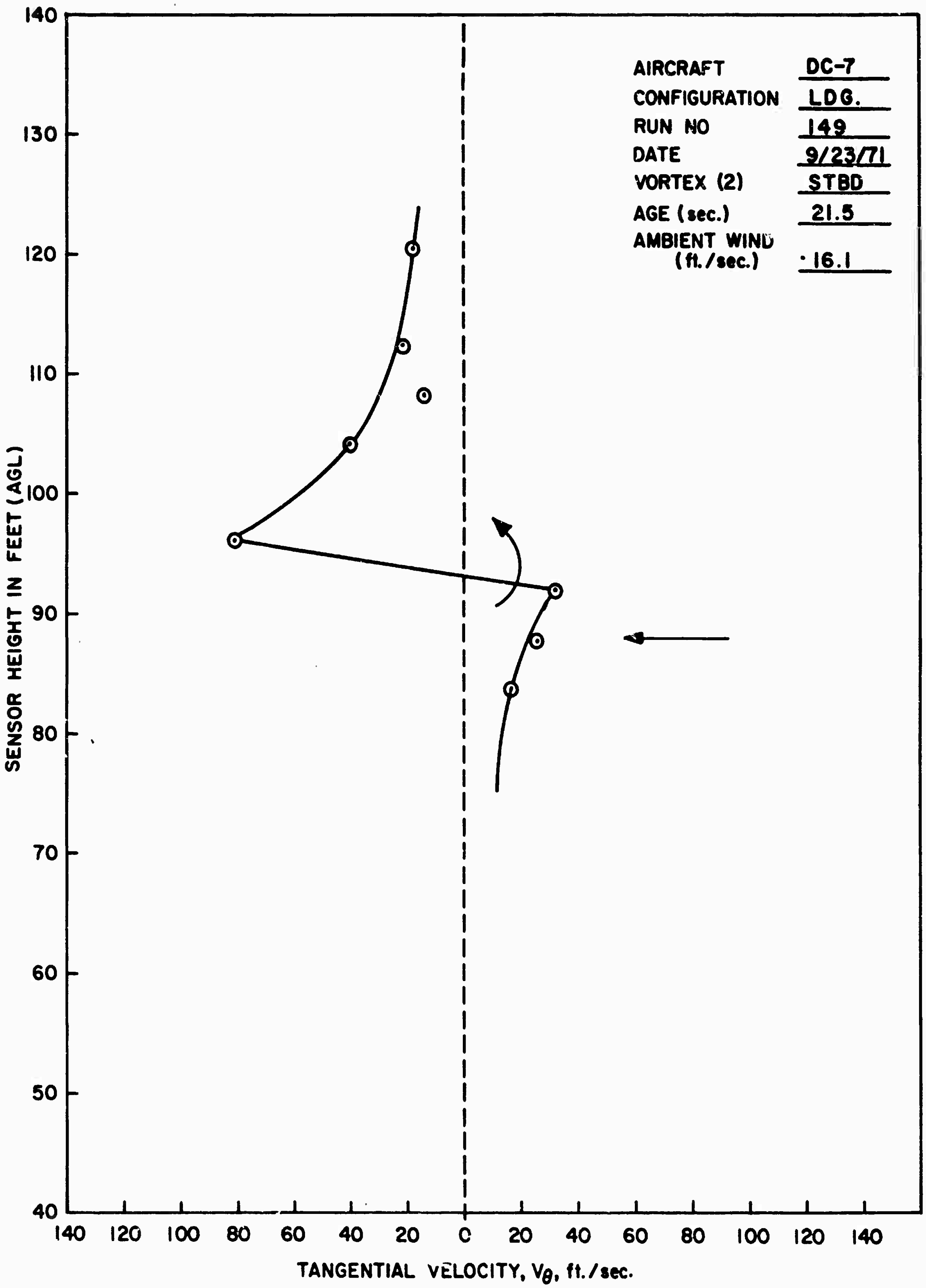
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 151
DATE 9/23/71
VORTEX (2) STBD
AGE (sec.) 21
AMBIENT WIND (ft./sec.) 13
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

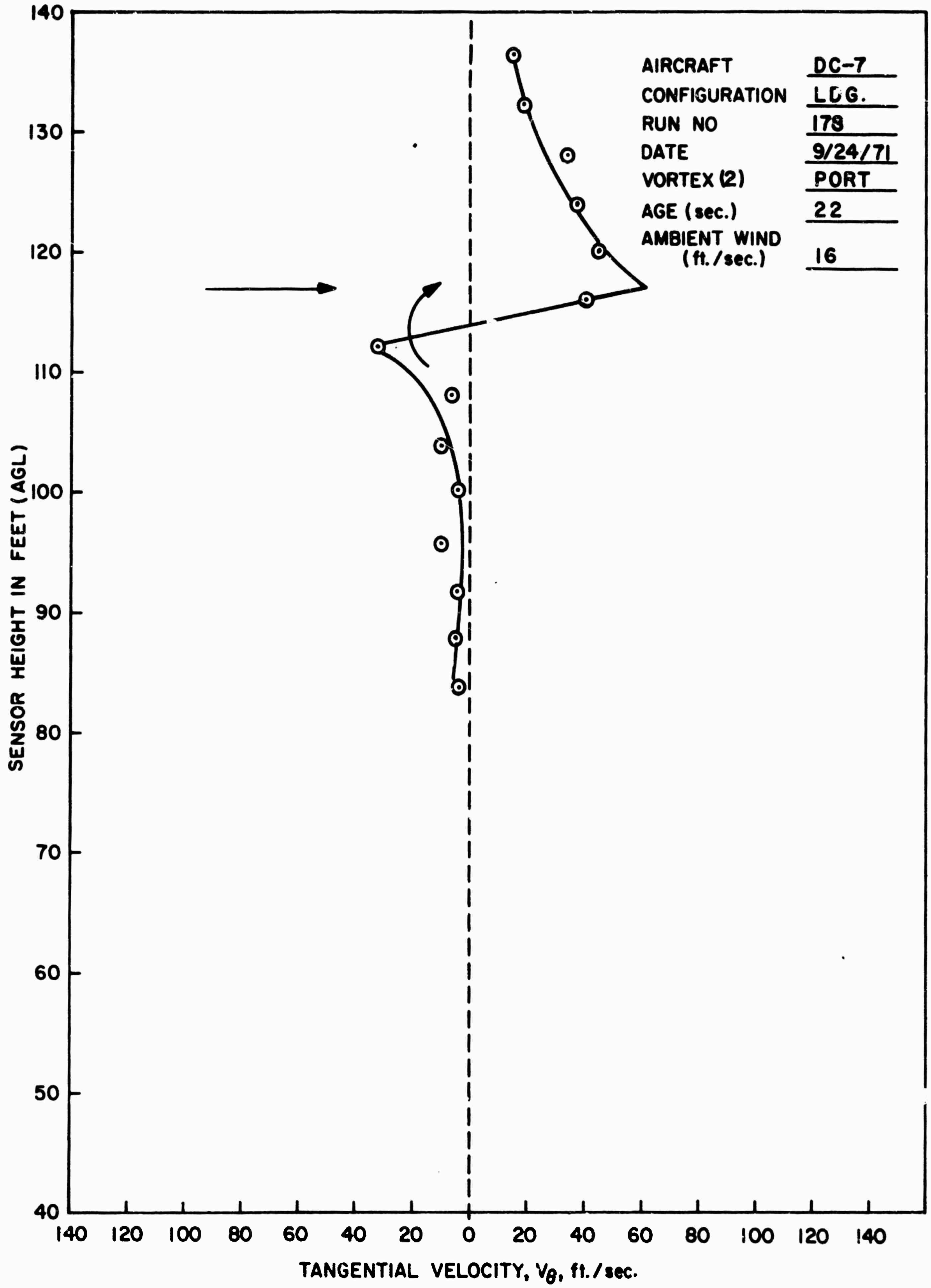


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 107
DATE 9/17/71
VORTEX (2) STBD
AGE (sec.) 21.5
AMBIENT WIND (ft./sec.) 14.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

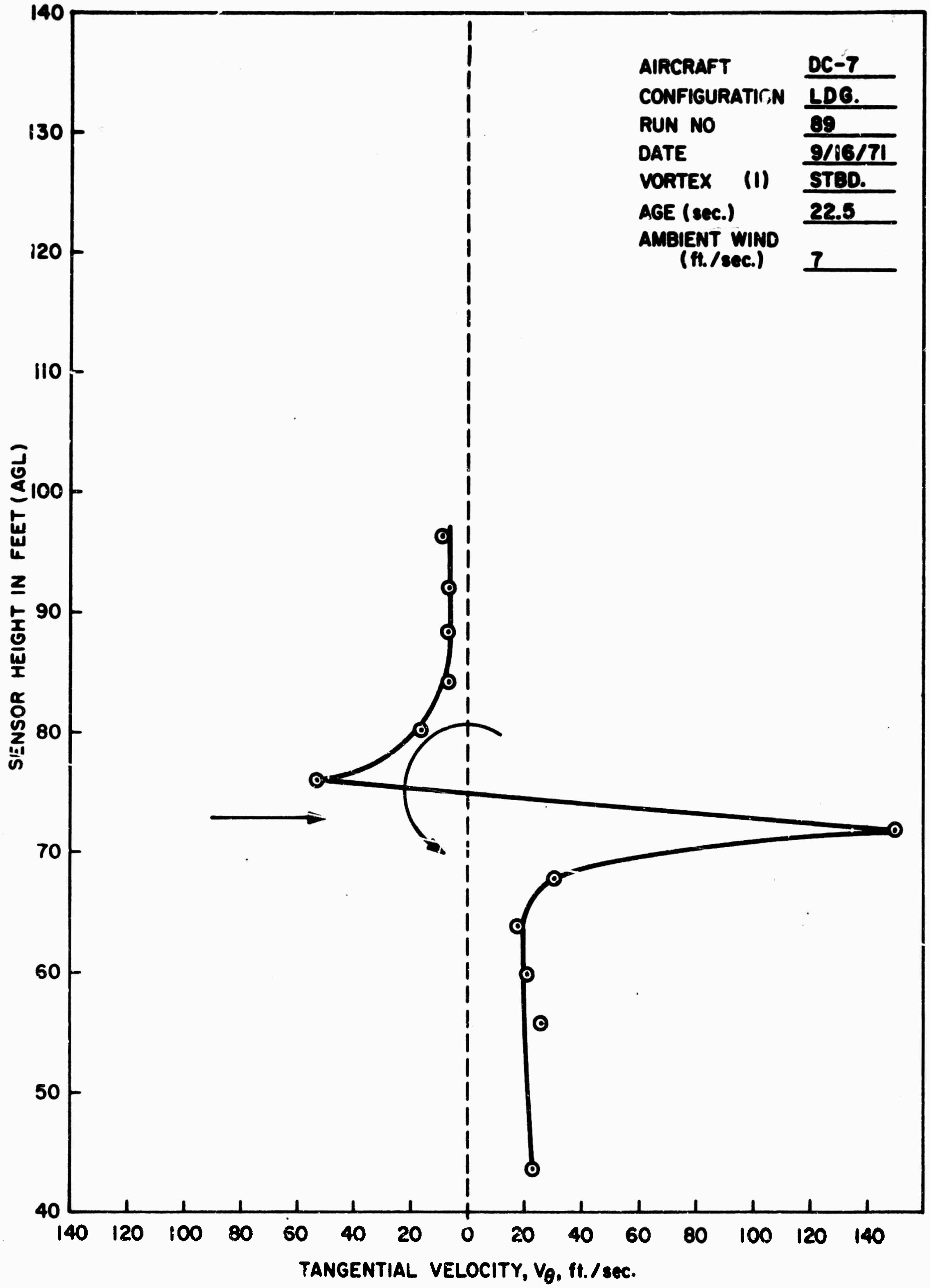


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 122
DATE 9/22/71
VORTEX (2) STBD
AGE (sec.) 21.5
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

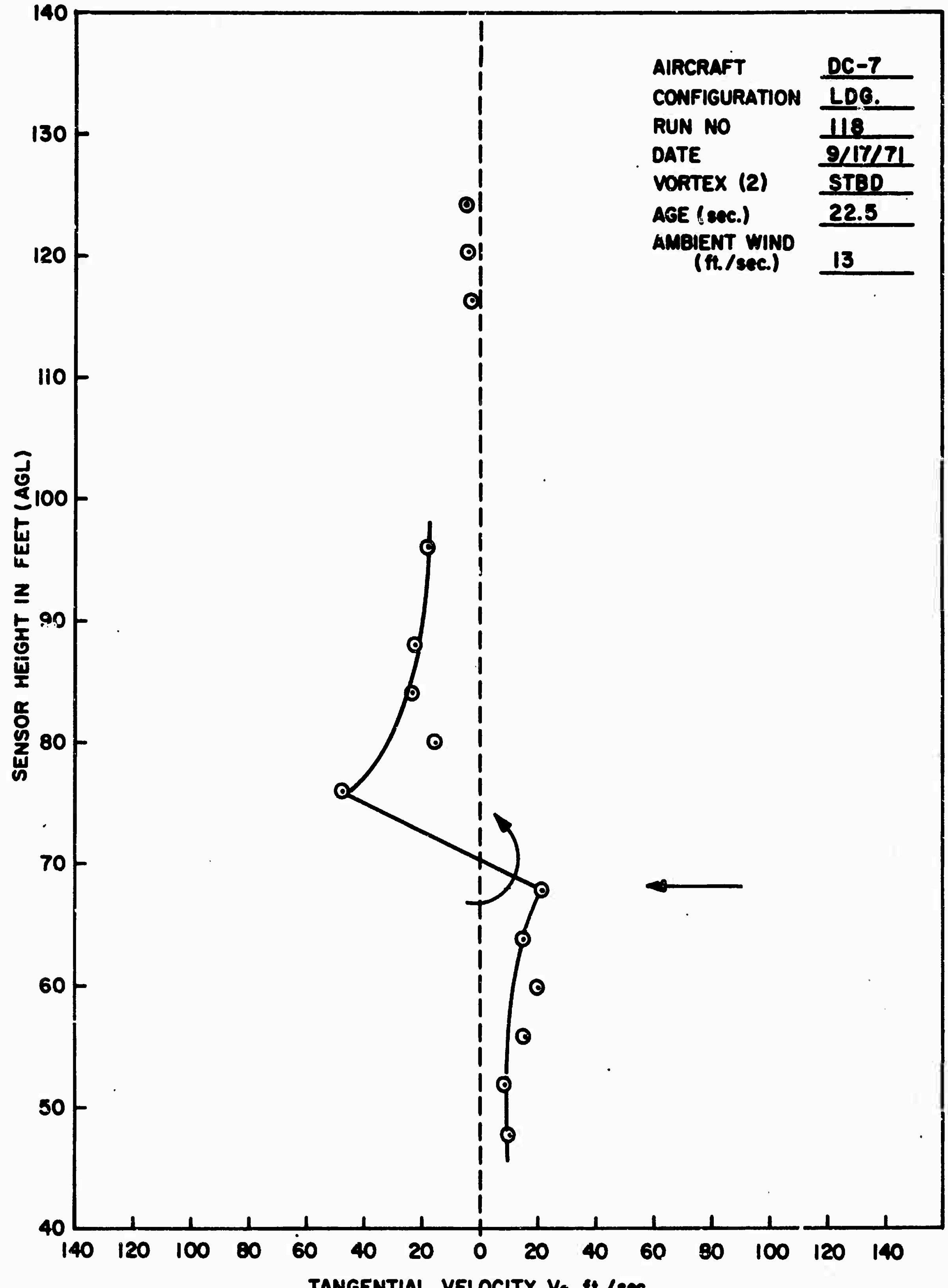

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 149
DATE 9/23/71
VORTEX (2) STBD
AGE (sec.) 21.5
AMBIENT WIND (ft./sec.) ·16.1
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



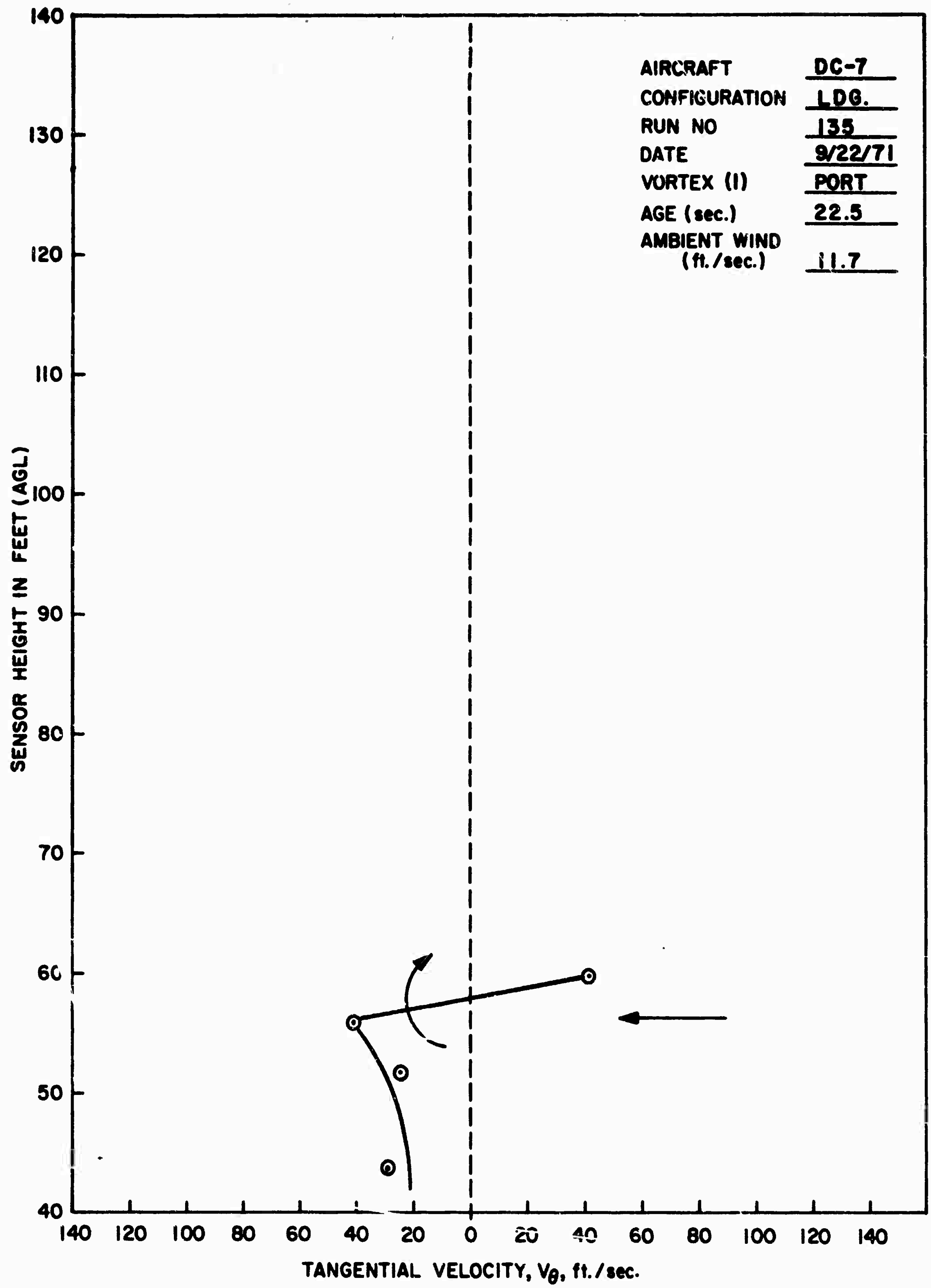
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 178
DATE 9/24/71
VORTEX (2) PORT
AGE (sec.) 22
AMBIENT WIND (ft./sec.) 16
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

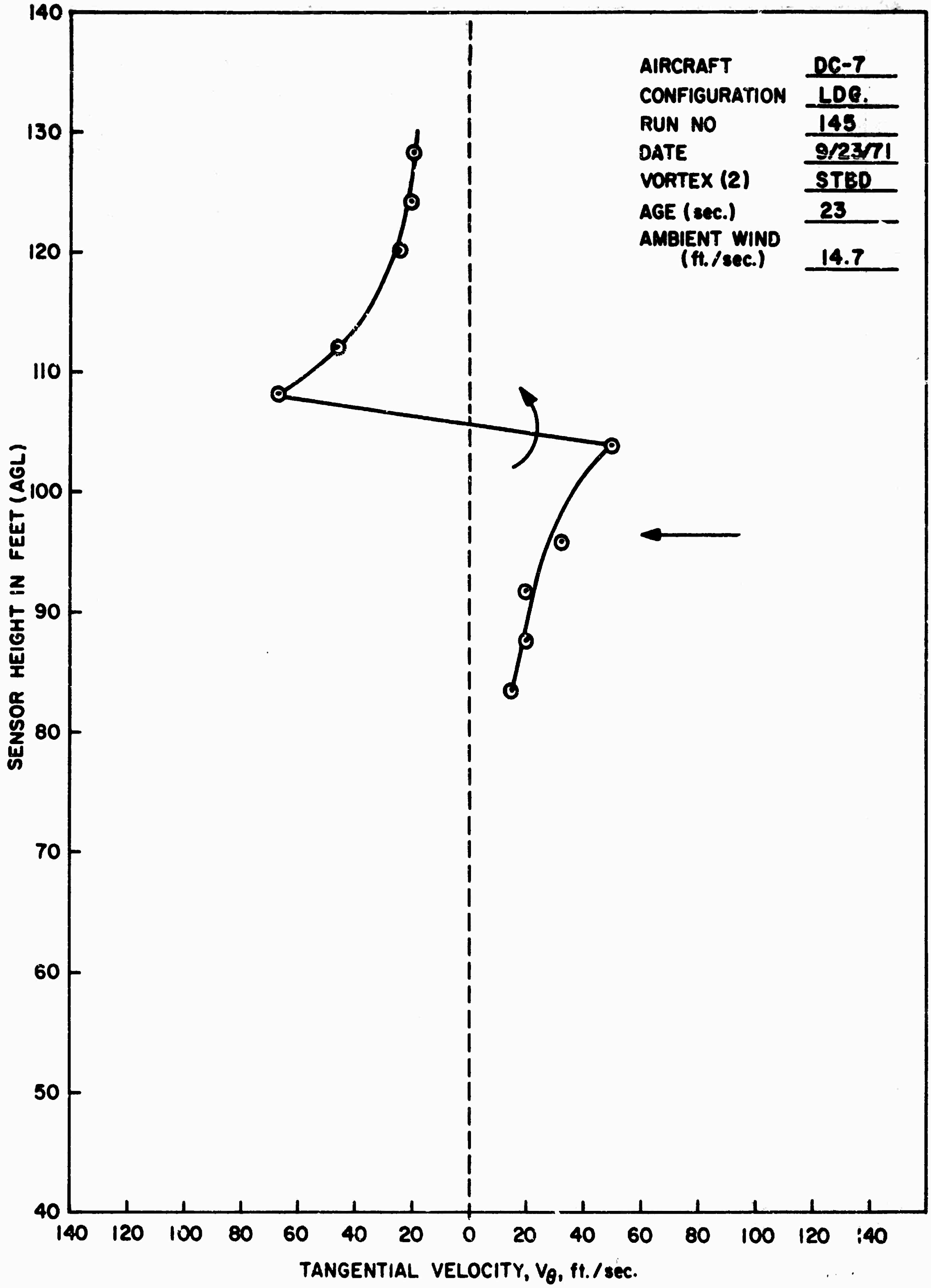


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 89
DATE 9/16/71
VORTEX (1) STBD.
AGE (sec.) 22.5
AMBIENT WIND (ft./sec.) 7
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

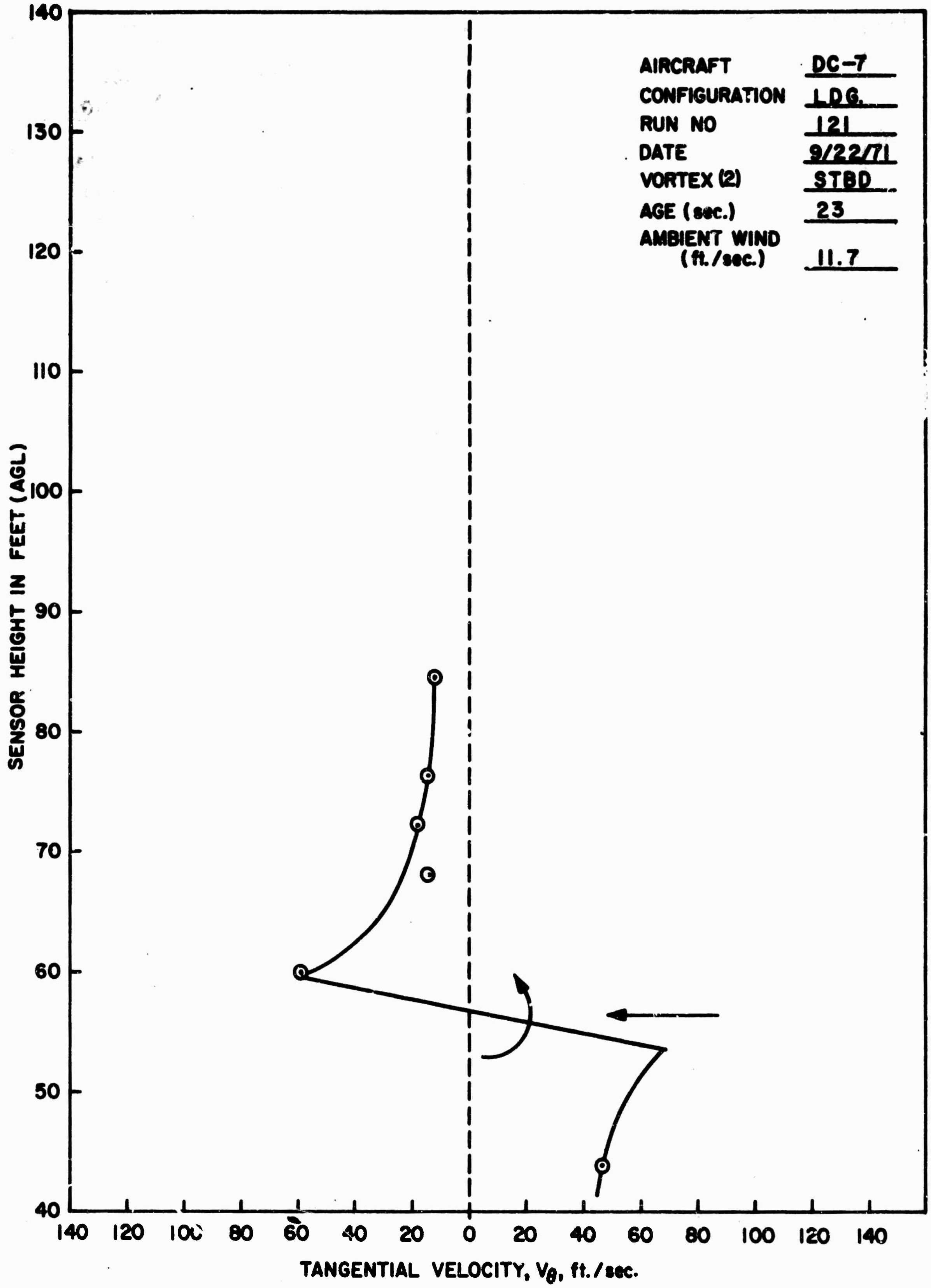


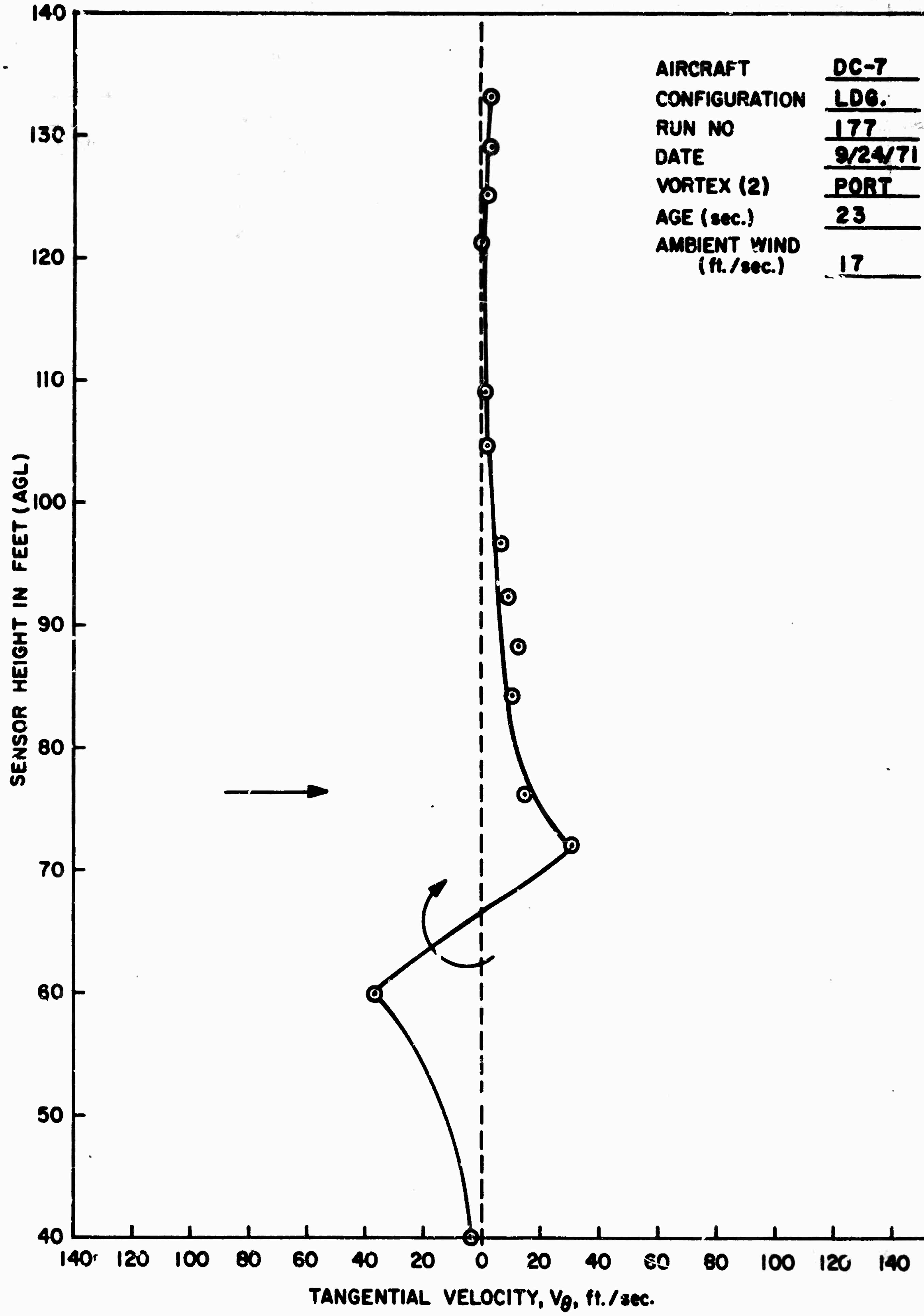
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 118
DATE 9/17/71
VORTEX (2) STBD
AGE (sec.) 22.5
AMBIENT WIND (ft./sec.) 13
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 135
DATE 9/22/71
VORTEX (1) PORT
AGE (sec.) 22.5
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

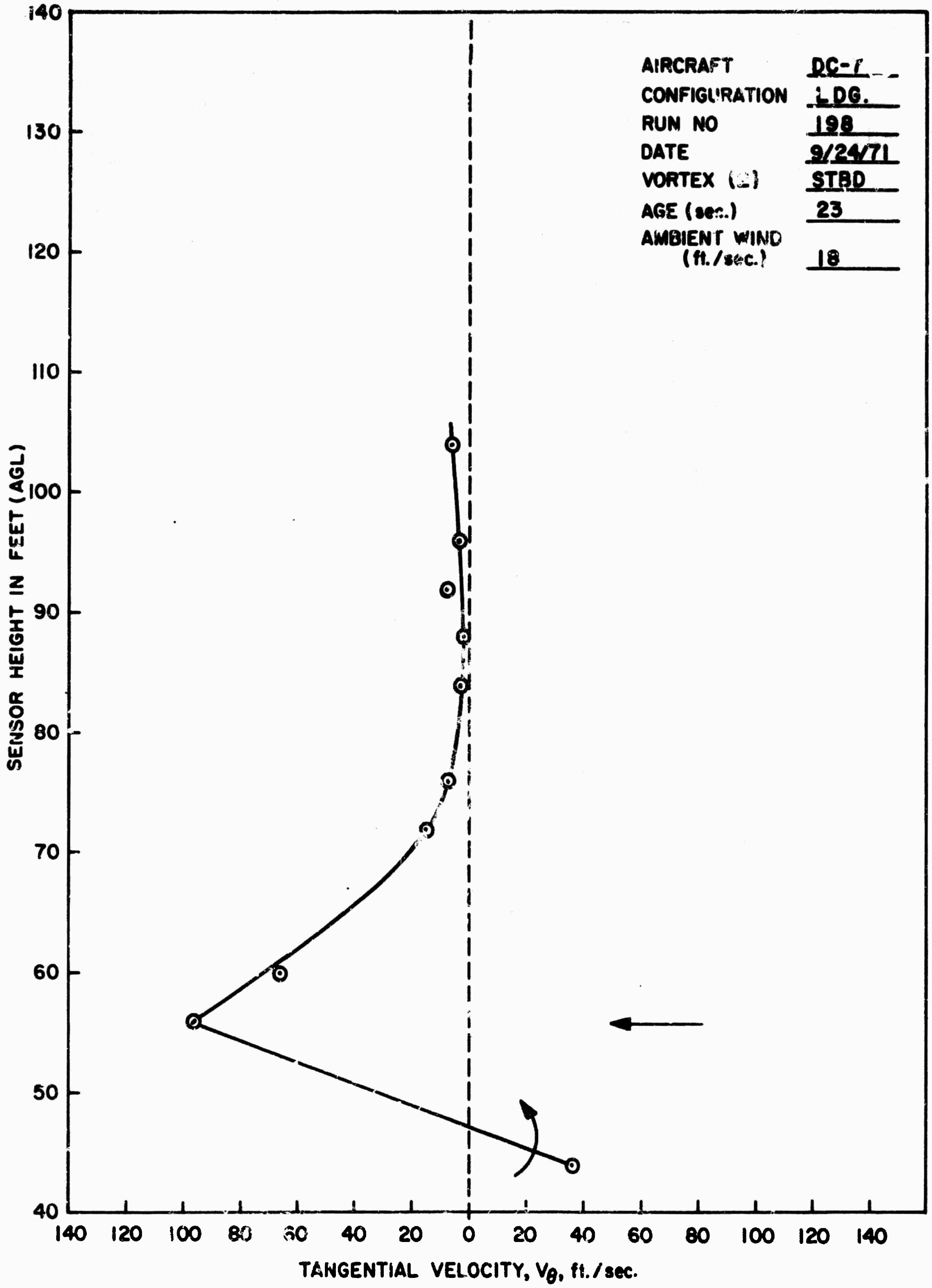


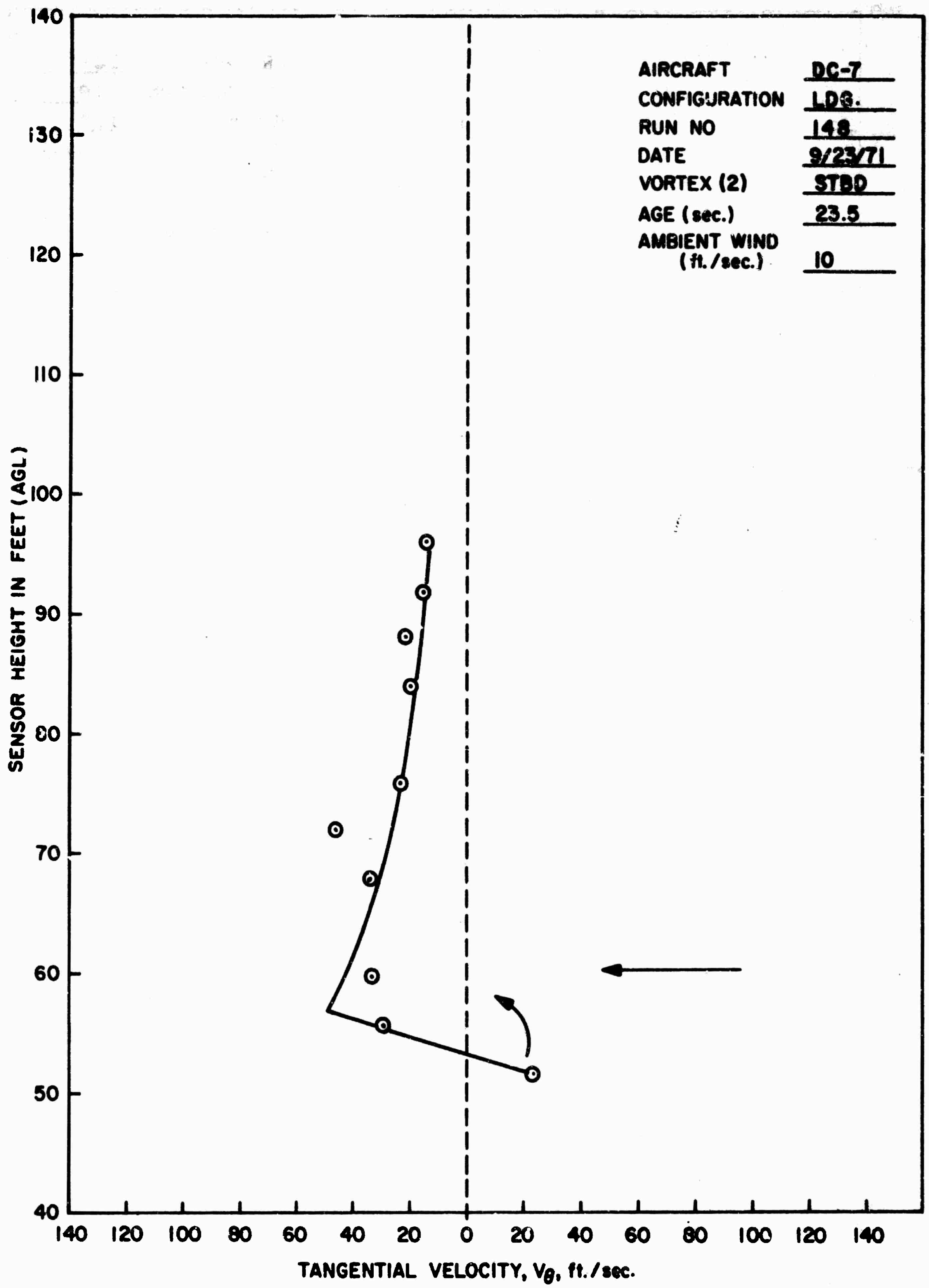
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 145
DATE 9/23/71
VORTEX (2) STBD
AGE (sec.) 23
AMBIENT WIND (ft./sec.) 14.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

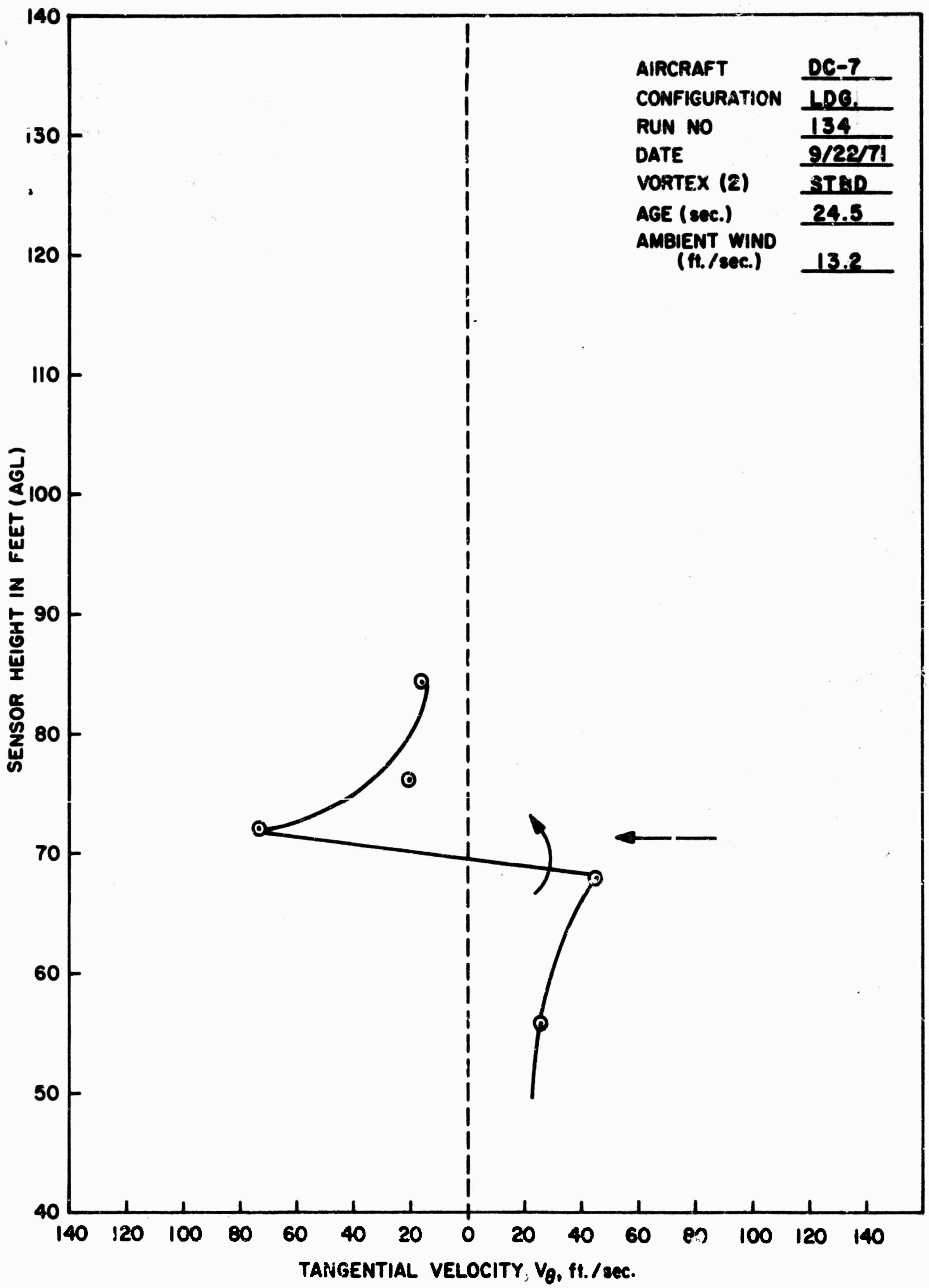

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 121
DATE 9/22/71
VORTEX (2) STBD
AGE (sec.) 23
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

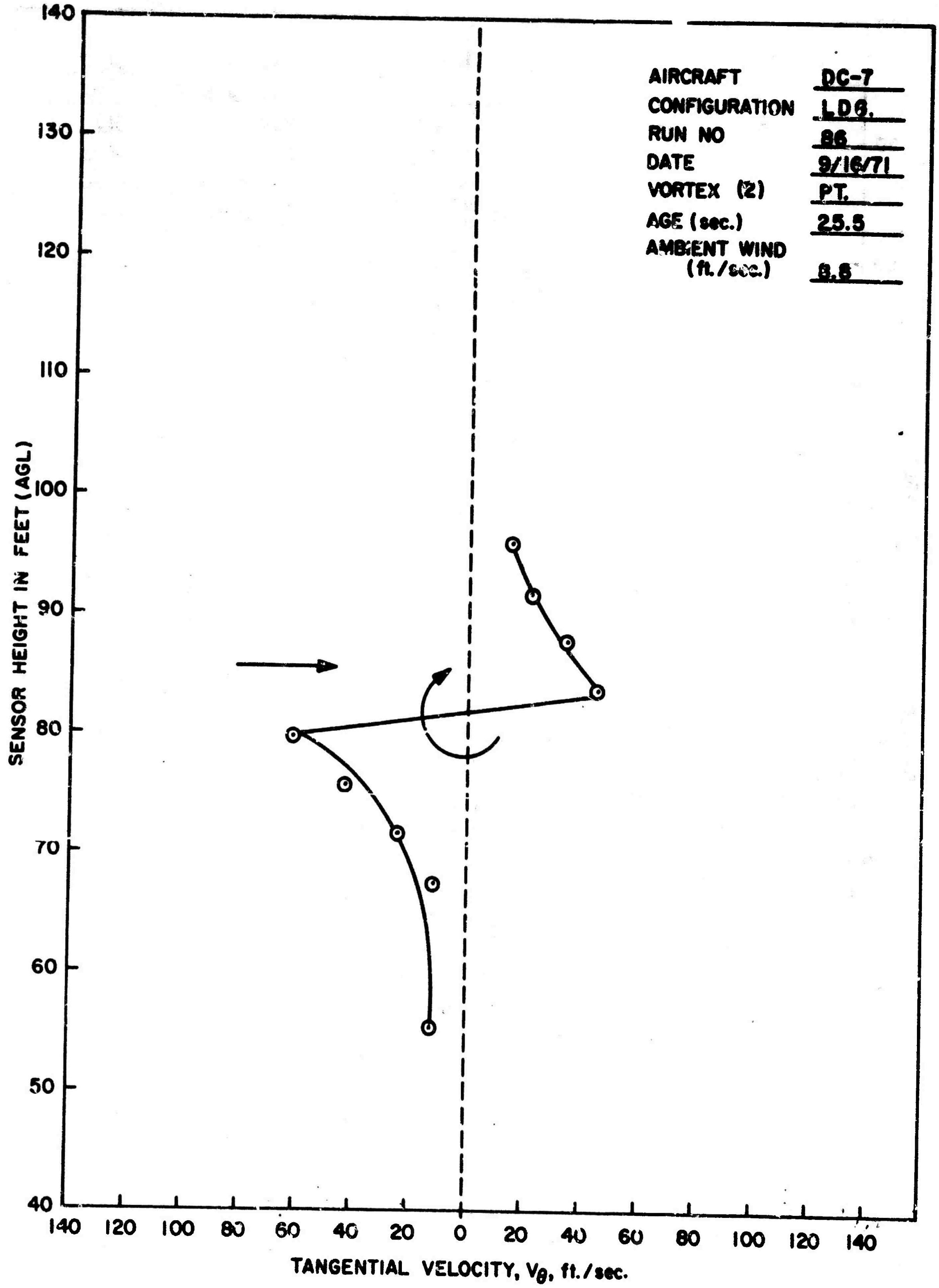


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 177
DATE 9/24/71
VORTEX (2) PORT
AGE (sec.) 23
AMBIENT WIND (ft./sec.) 17
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

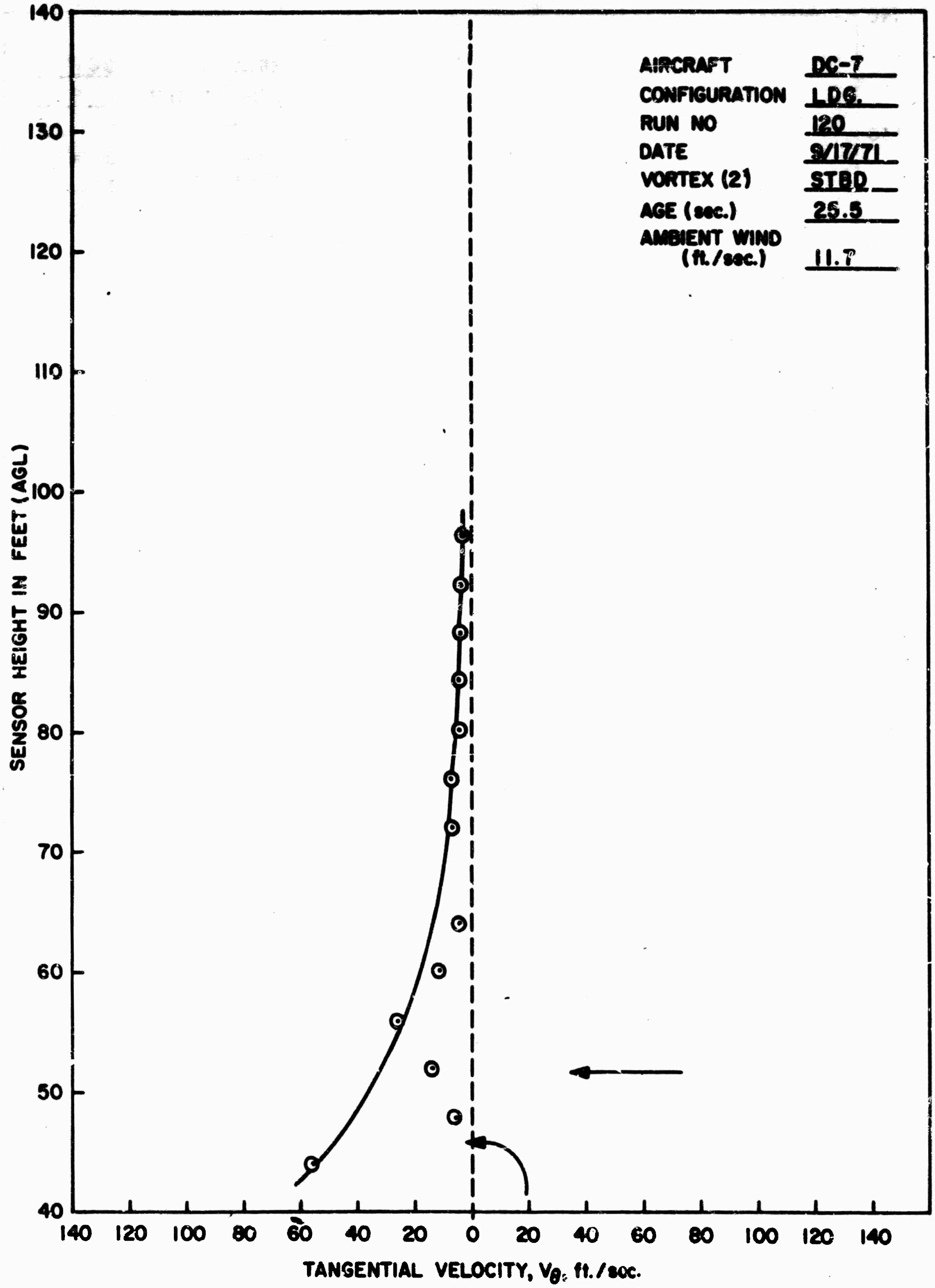

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 198
DATE 9/24/71
VORTEX (℄) STBD
AGE (sec.) 23
AMBIENT WIND (ft./sec.) 18
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140 130 120 110 100 90 80 70 60 50 40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

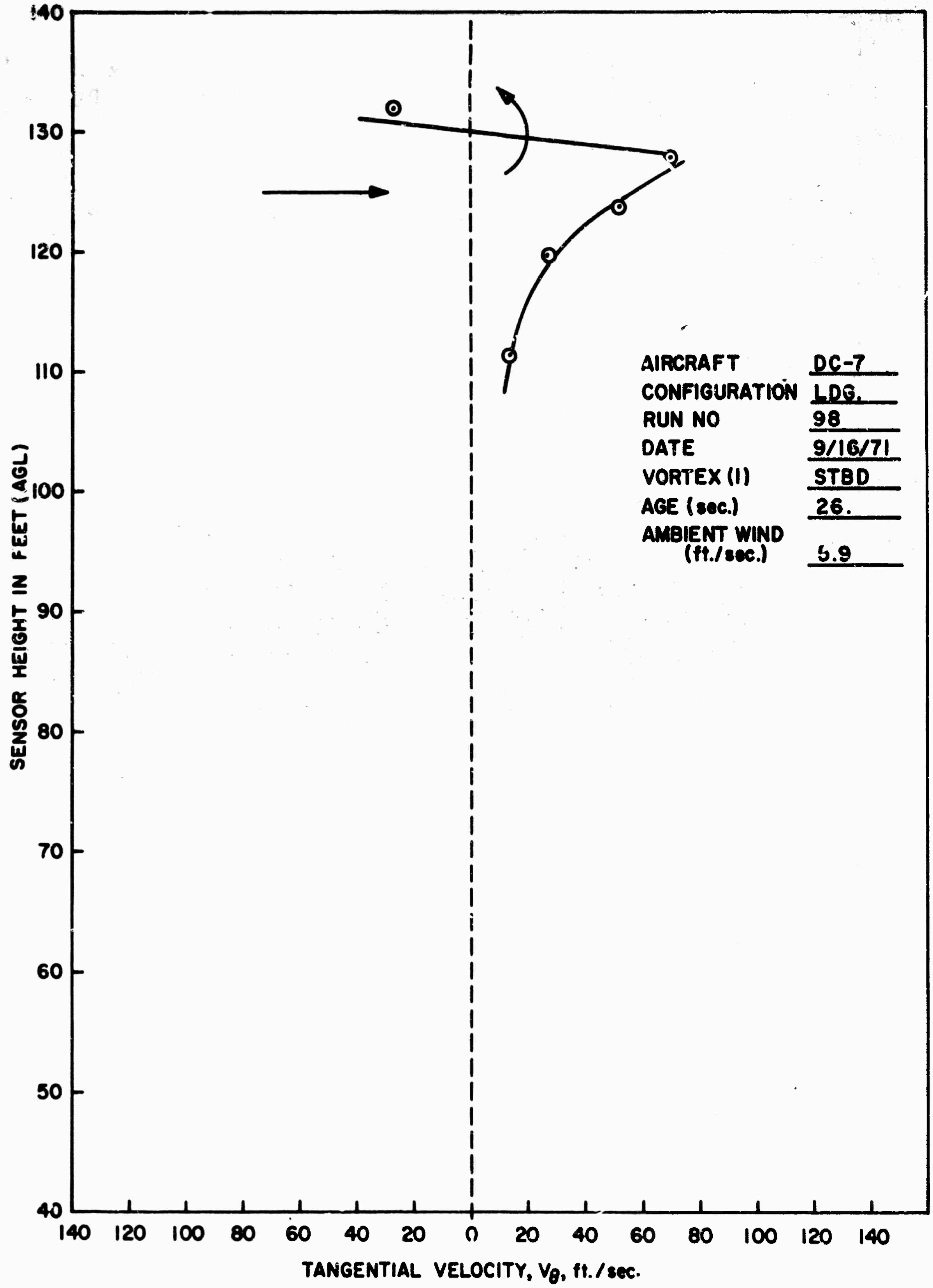

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 148
DATE 9/23/71
VORTEX (2) STBD
AGE (sec.) 23.5
AMBIENT WIND (ft./sec.) 10
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 134
DATE 9/22/71
VORTEX (2) STBD
AGE (sec.) 24.5
AMBIENT WIND (ft./sec.) 13.2
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

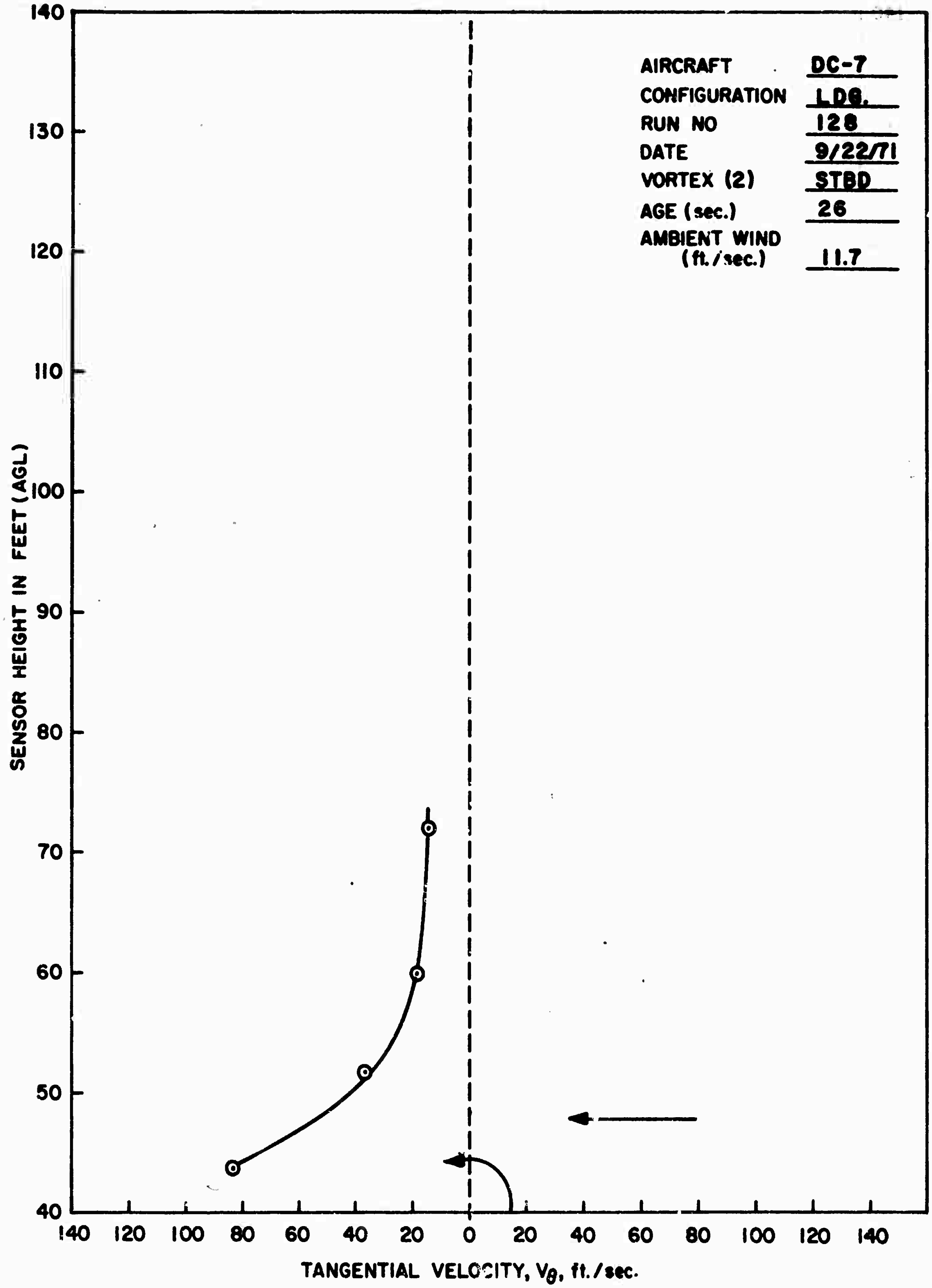


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 86
DATE 9/16/71
VORTEX (2) PT.
AGE (sec.) 25.5
AMBIENT WIND (ft./sec.) 8.8
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

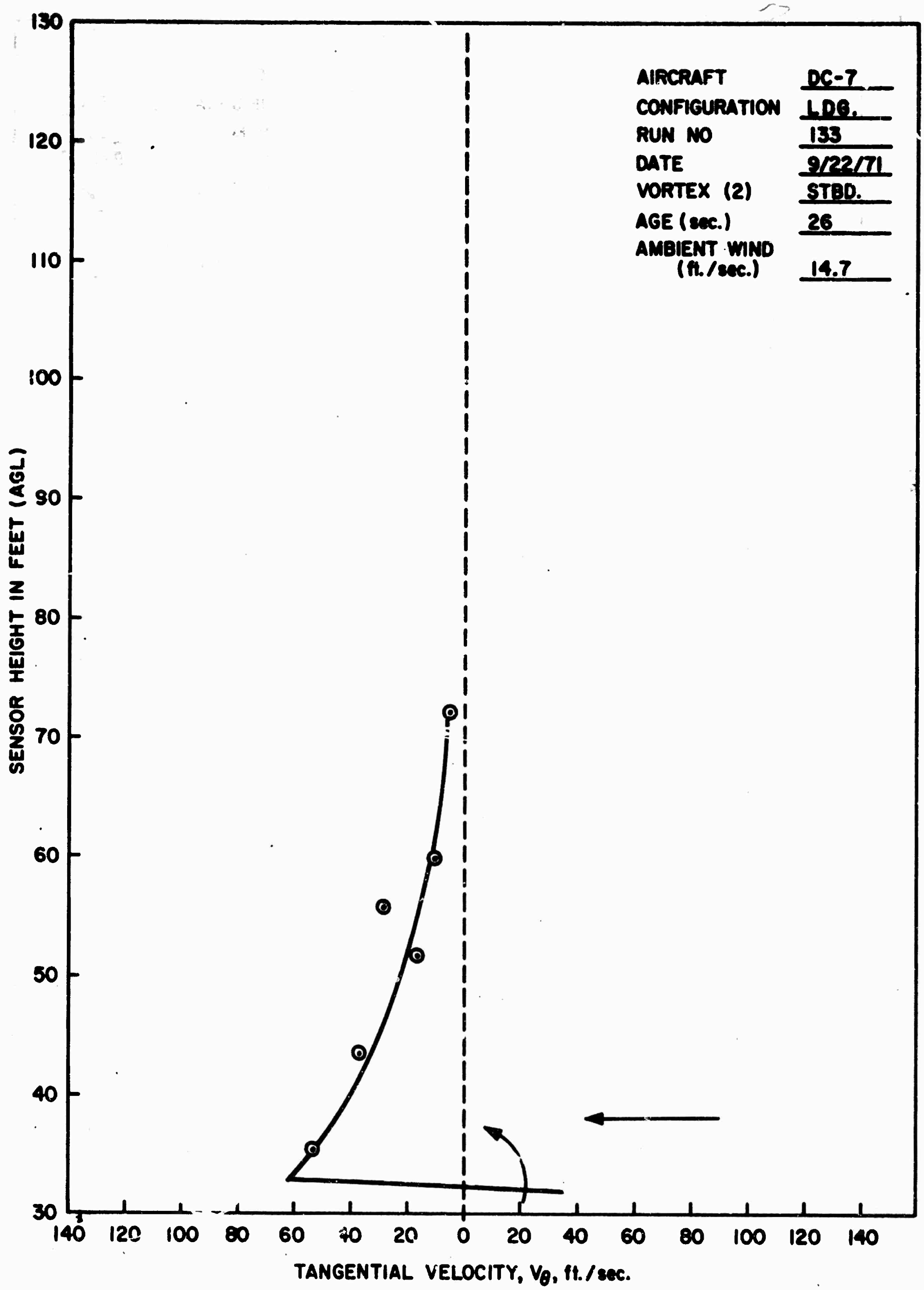

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 120
DATE 9/17/71
VORTEX (2) STBD
AGE (sec.) 25.5
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

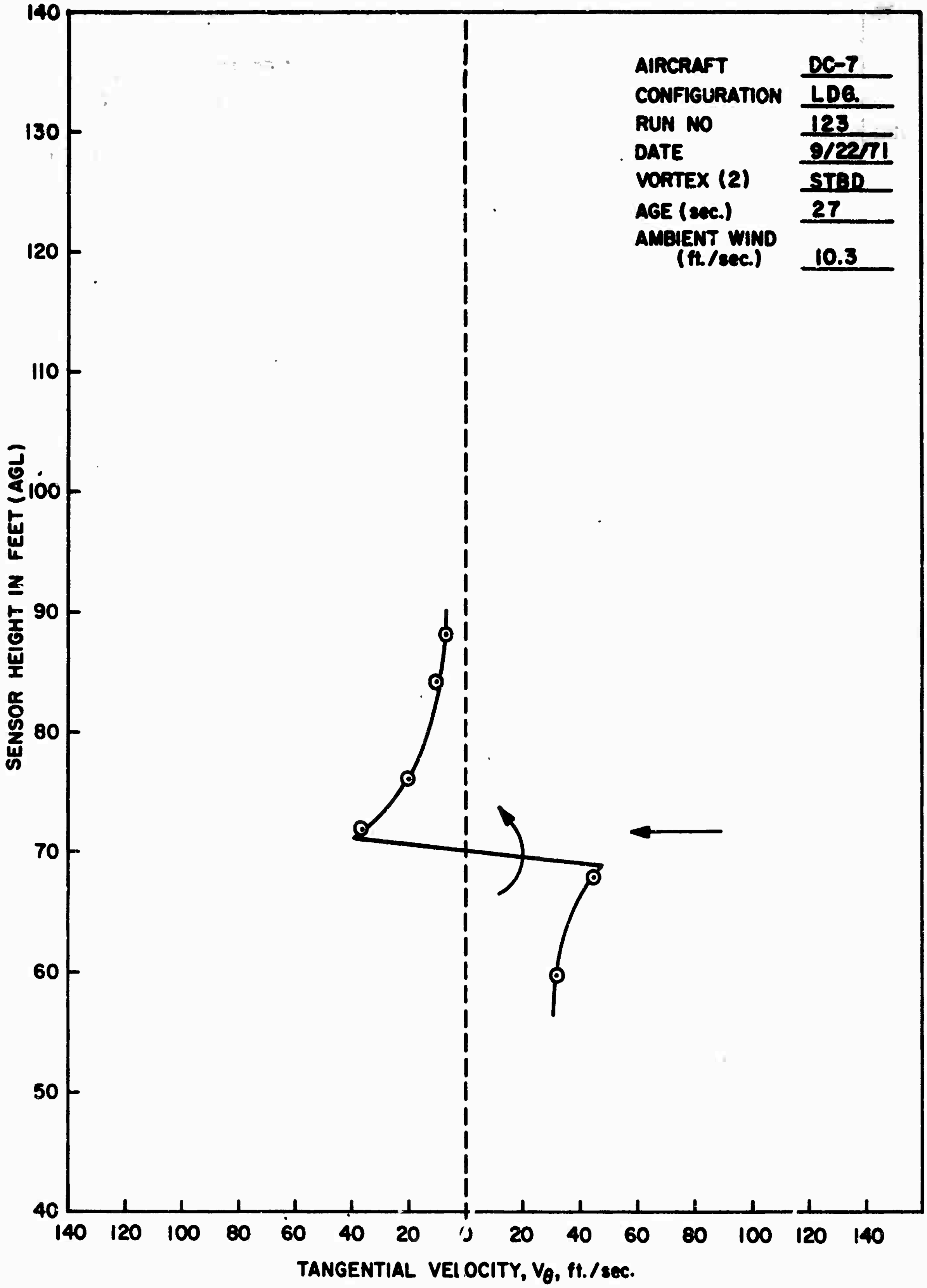


SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 98
DATE 9/16/71
VORTEX (I) STBD
AGE (sec.) 26.
AMBIENT WIND (ft./sec.) 5.9
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

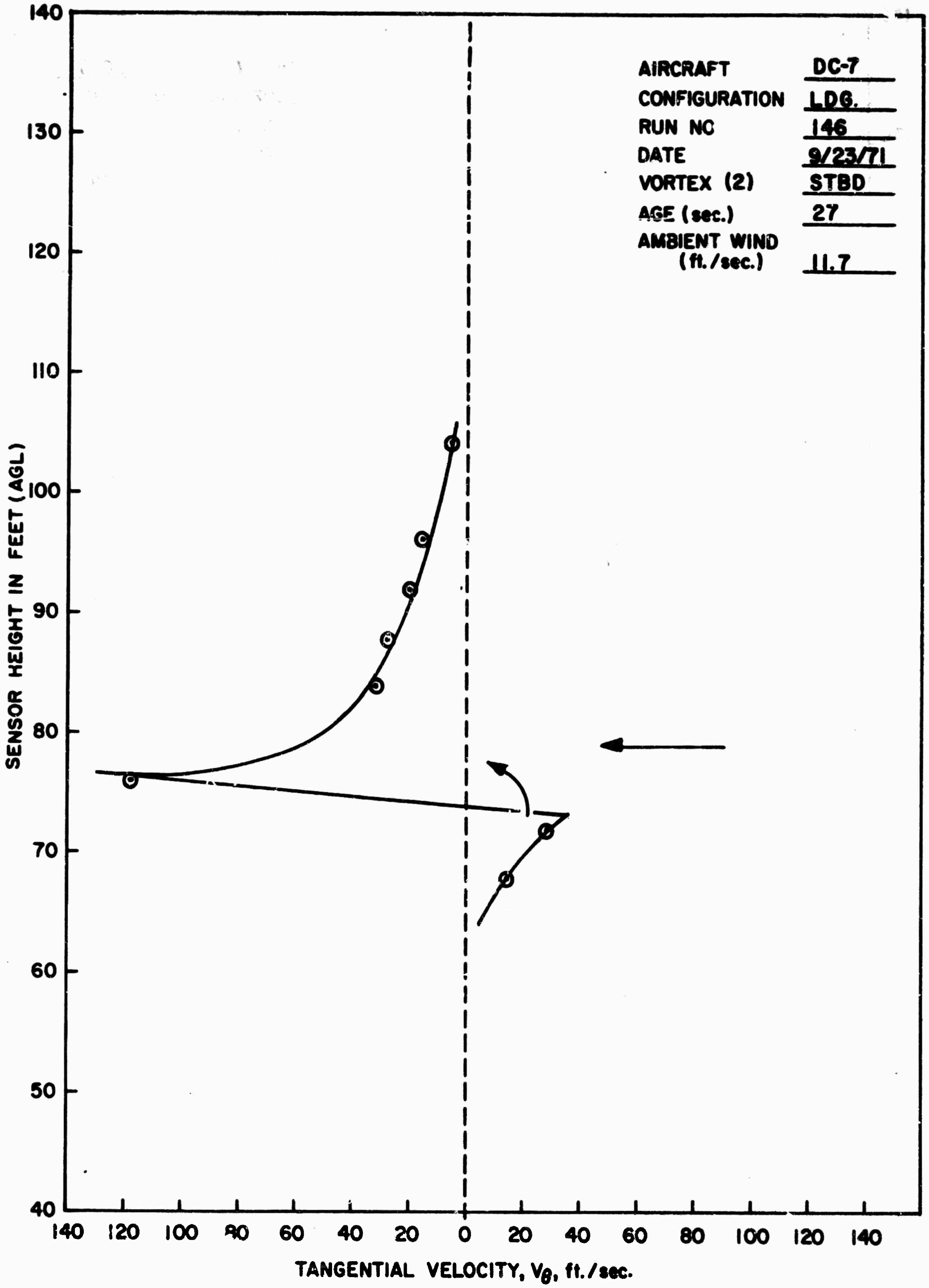


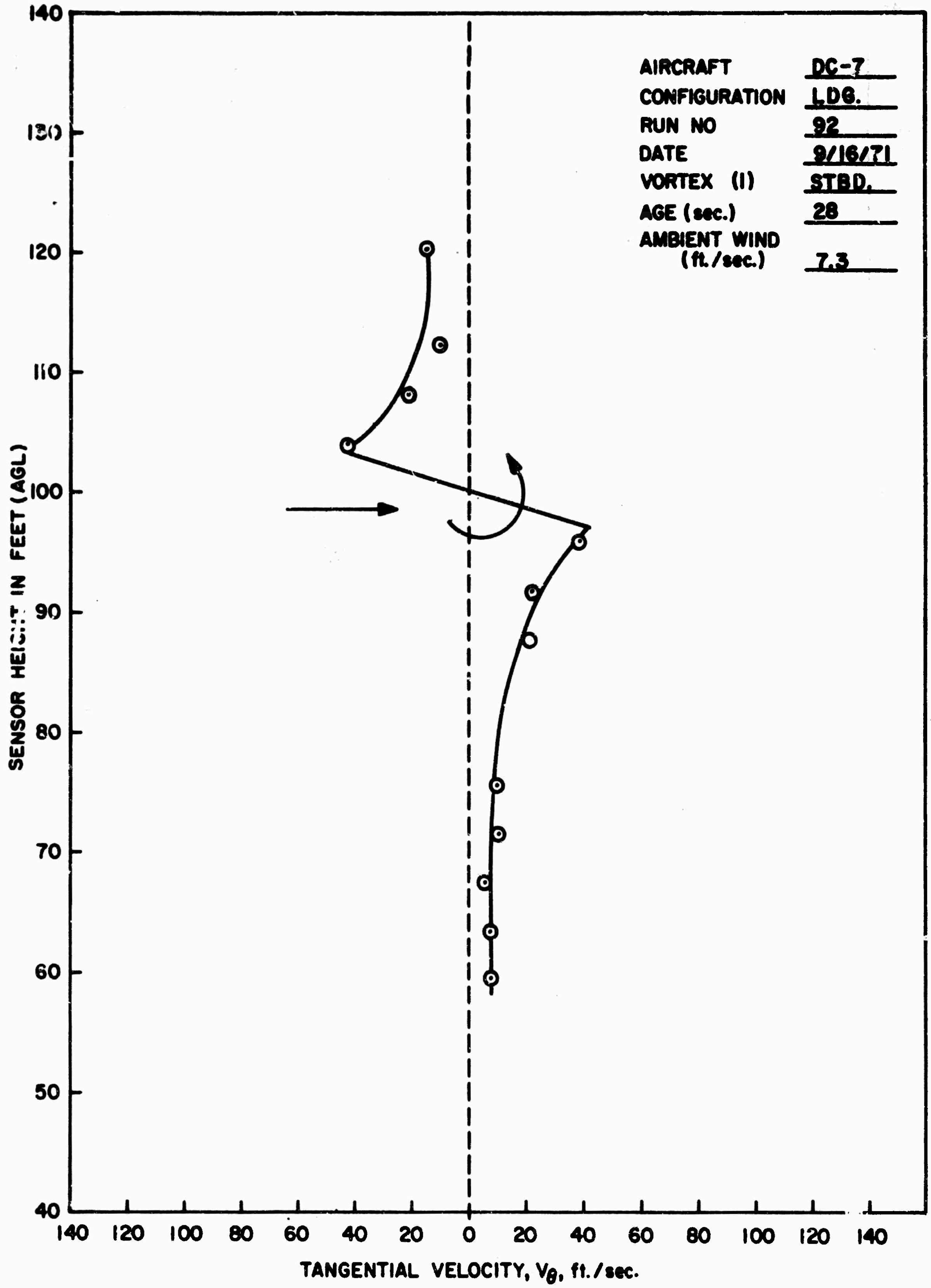
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 128
DATE 9/22/71
VORTEX (2) STBD
AGE (sec.) 26
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 133
DATE 9/22/71
VORTEX (2) STBD.
AGE (sec.) 26
AMBIENT WIND (ft./sec.) 14.7
SENSOR HEIGHT IN FEET (AGL)
130
120
110
100
90
80
70
60
50
40
30
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

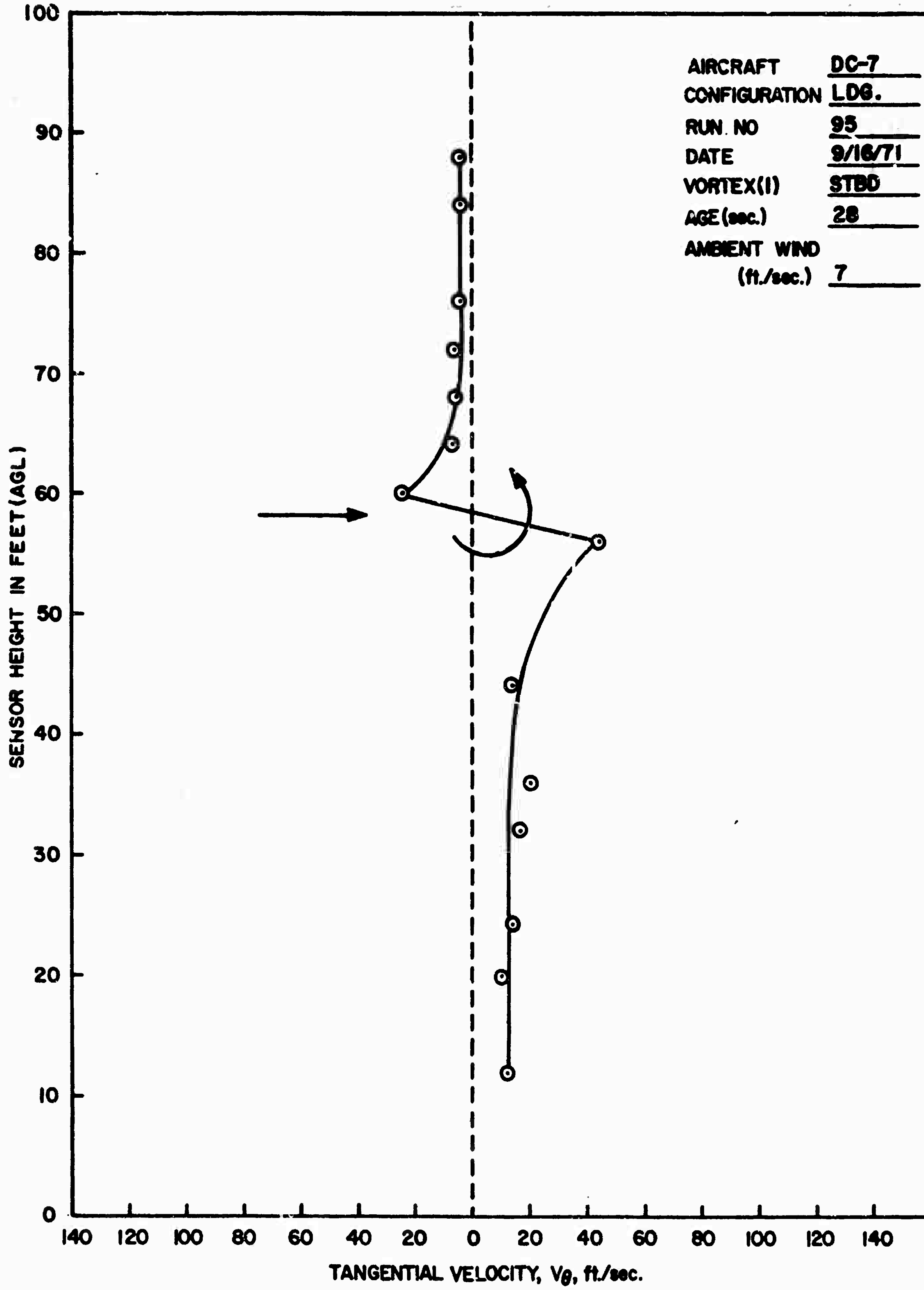


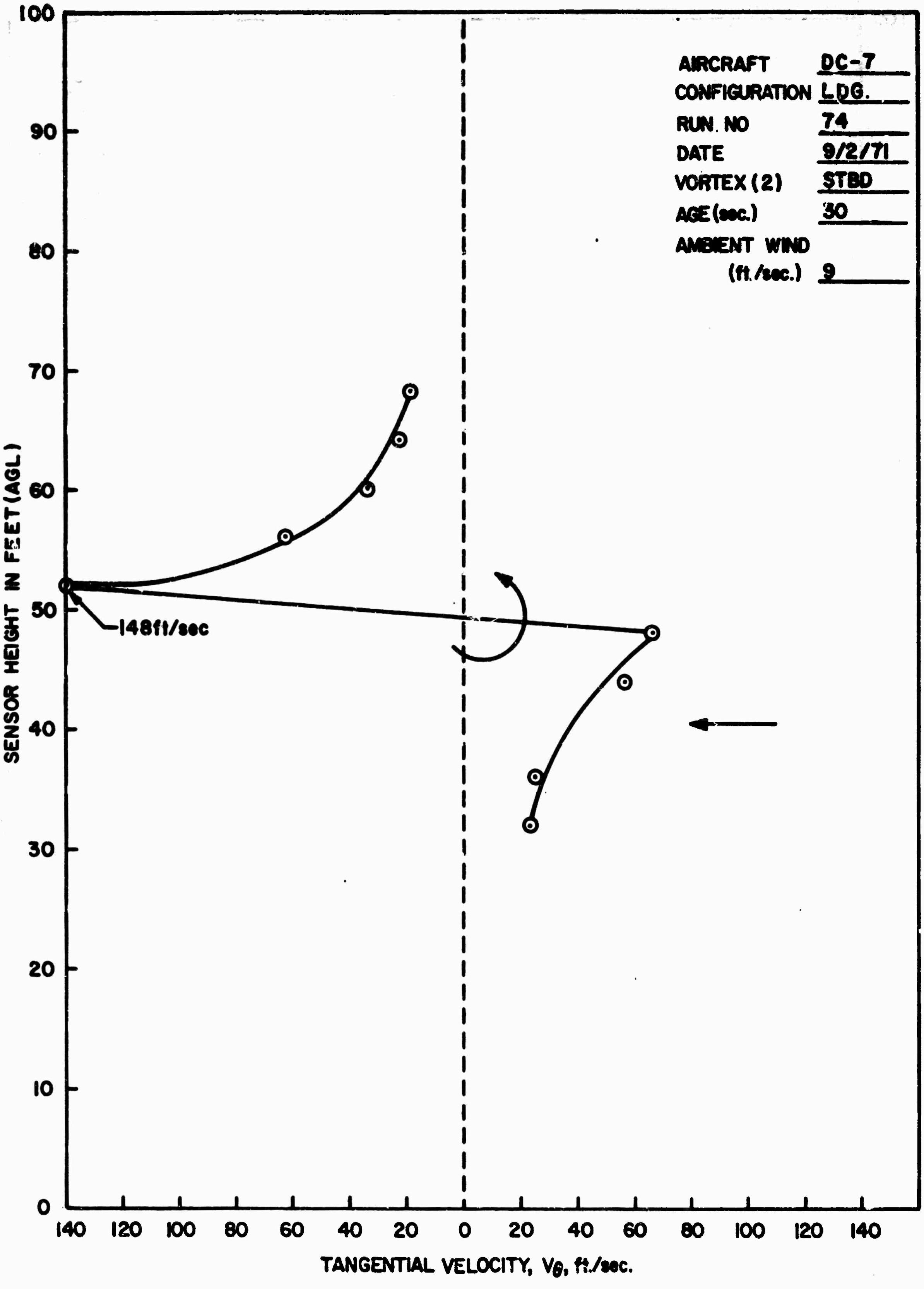
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 123
DATE 9/22/71
VORTEX (2) STBD
AGE (sec.) 27
AMBIENT WIND (ft./sec.) 10.3
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

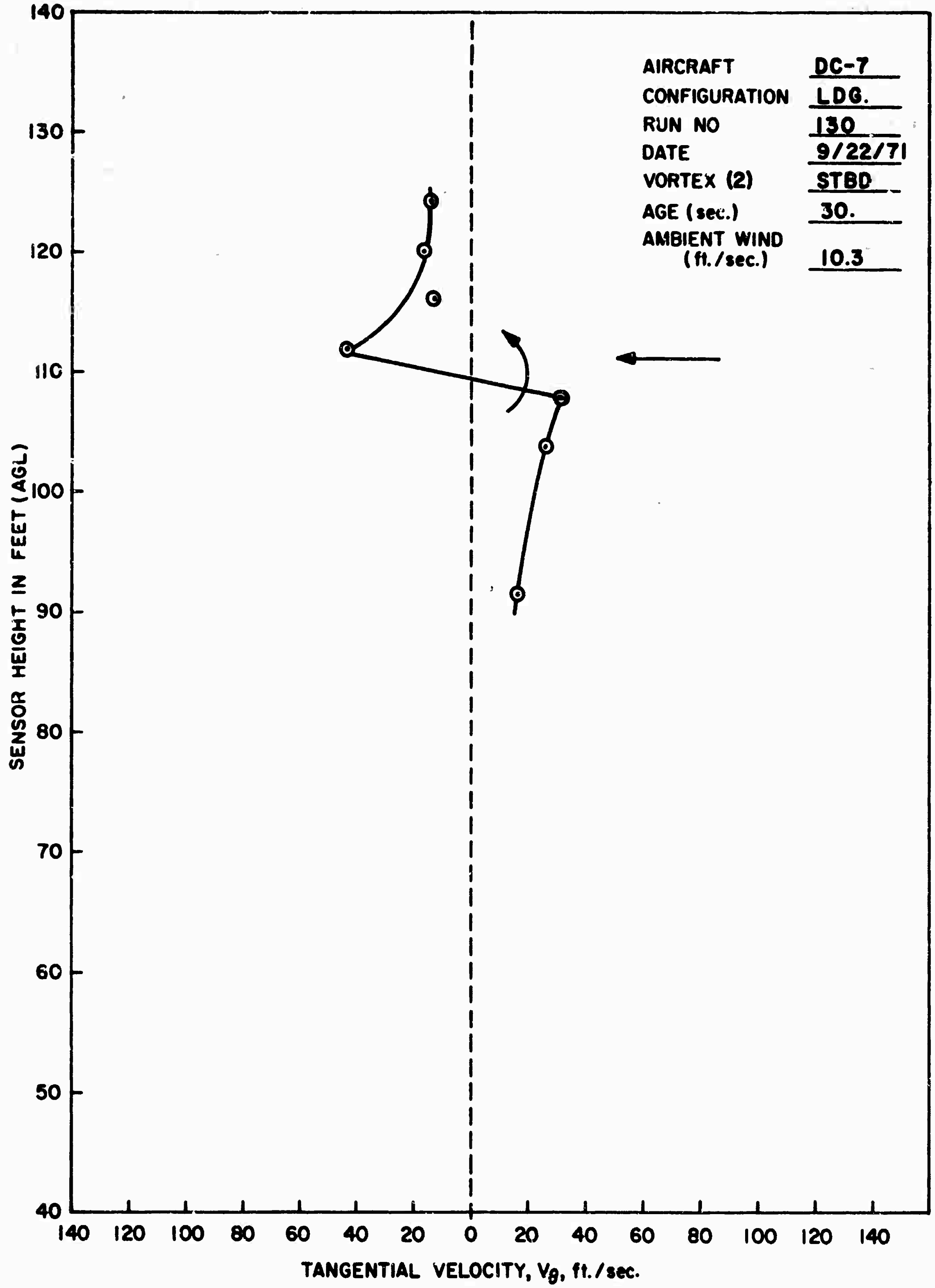

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 146
DATE 9/23/71
VORTEX (2) STBD
AGE (sec.) 27
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

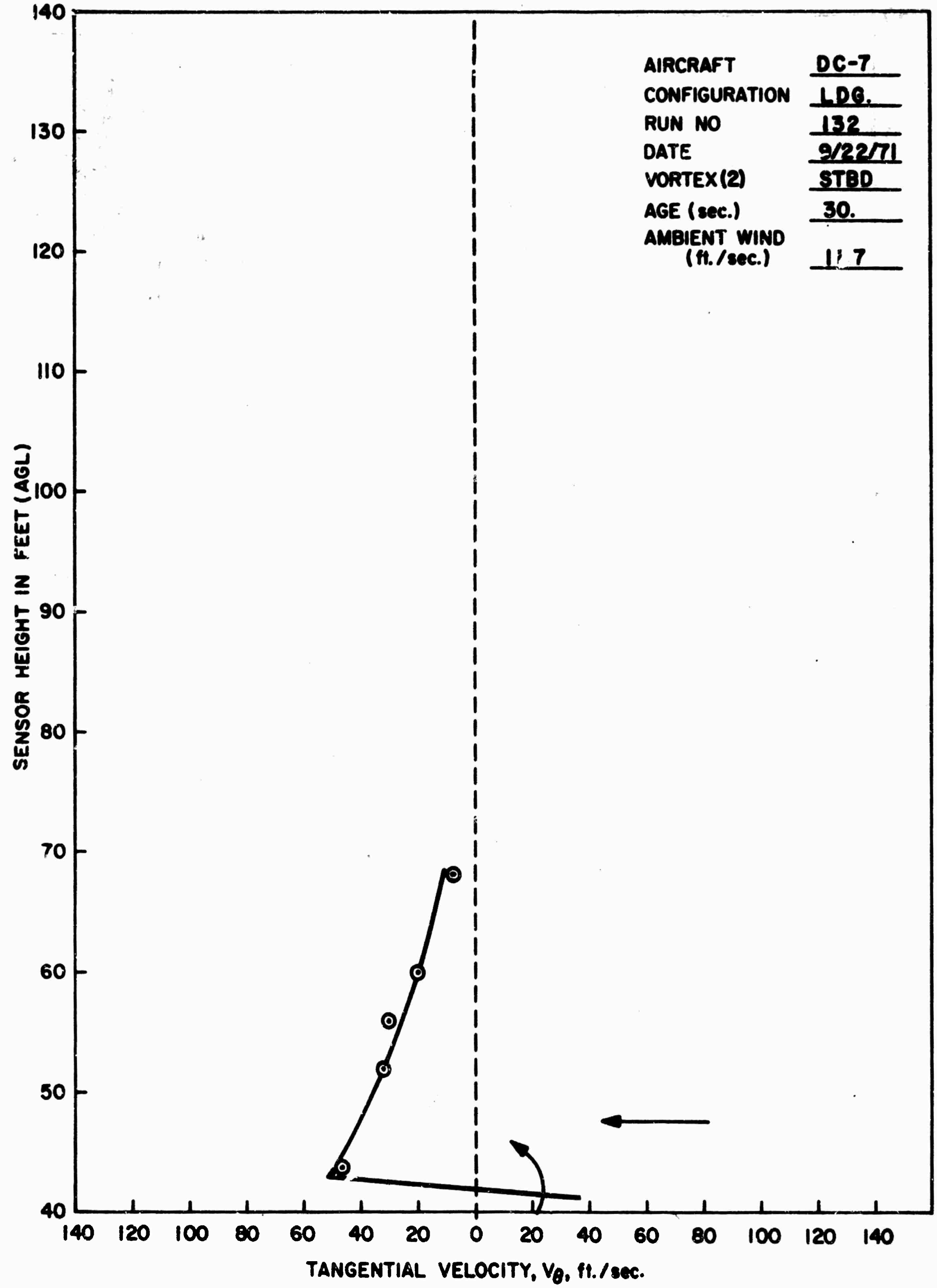


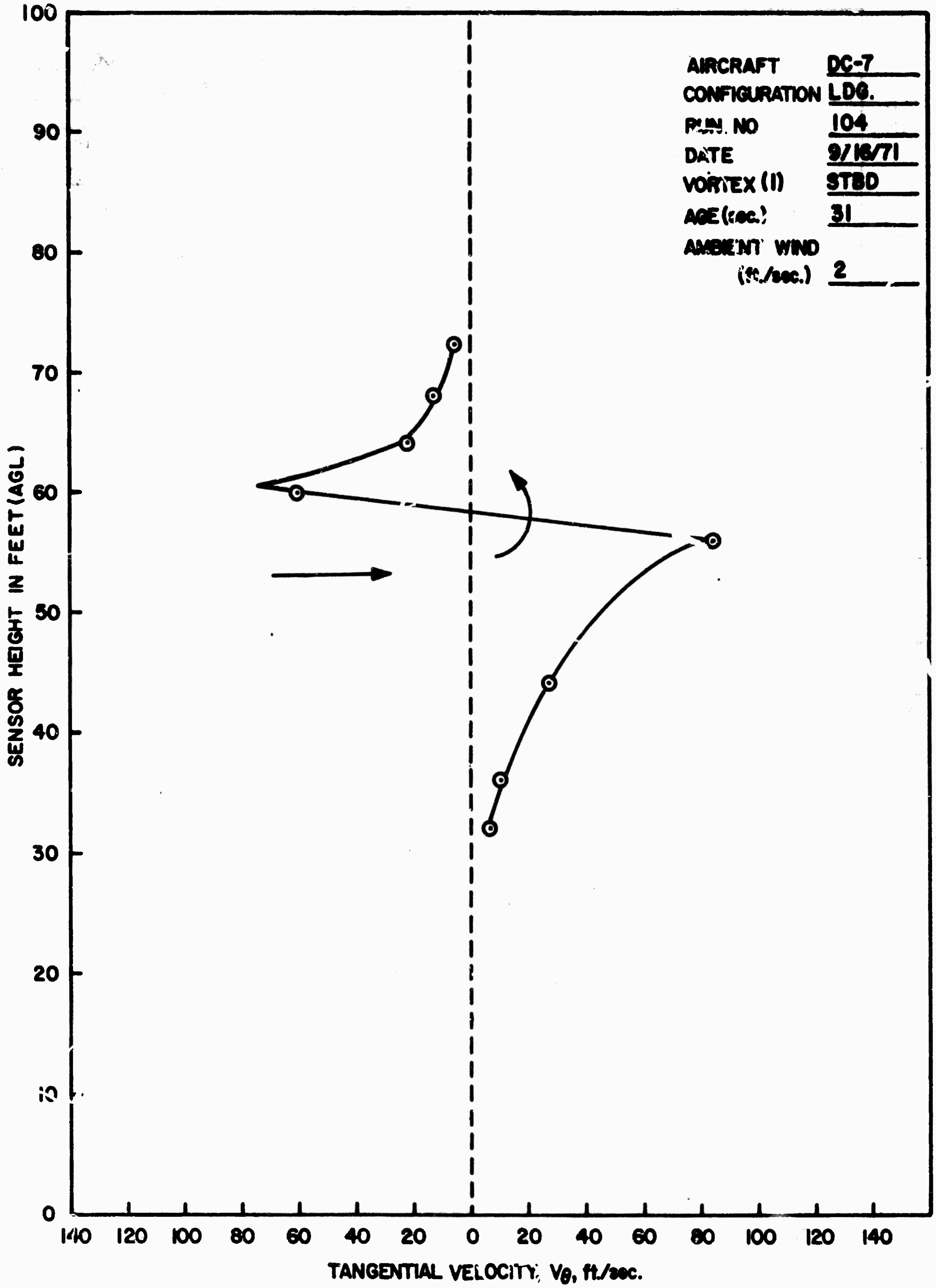
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 92
DATE 9/16/71
VORTEX (1) STBD.
AGE (sec.) 28
AMBIENT WIND (ft./sec.) 7.3
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

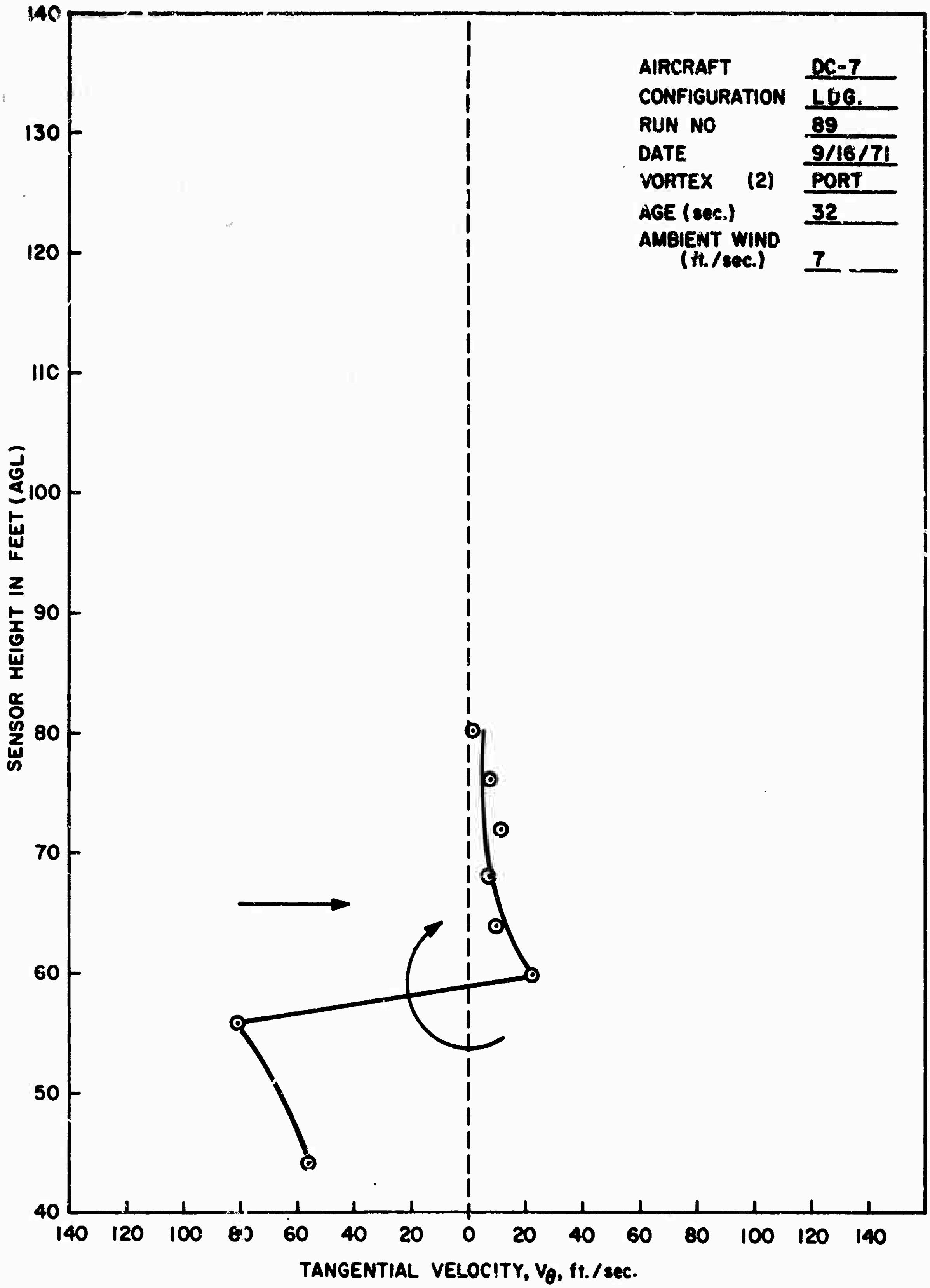

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN. NO 95
DATE 9/16/71
VORTEX(I) STBD
AGE (sec.) 28
AMBIENT WIND (ft./sec.) 7
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, Vθ, ft./sec.
0
10
20
30
40
50
60
70
80
90
100
140
120
100
80
60
40
20
0
20
40
60
80
100
120
140

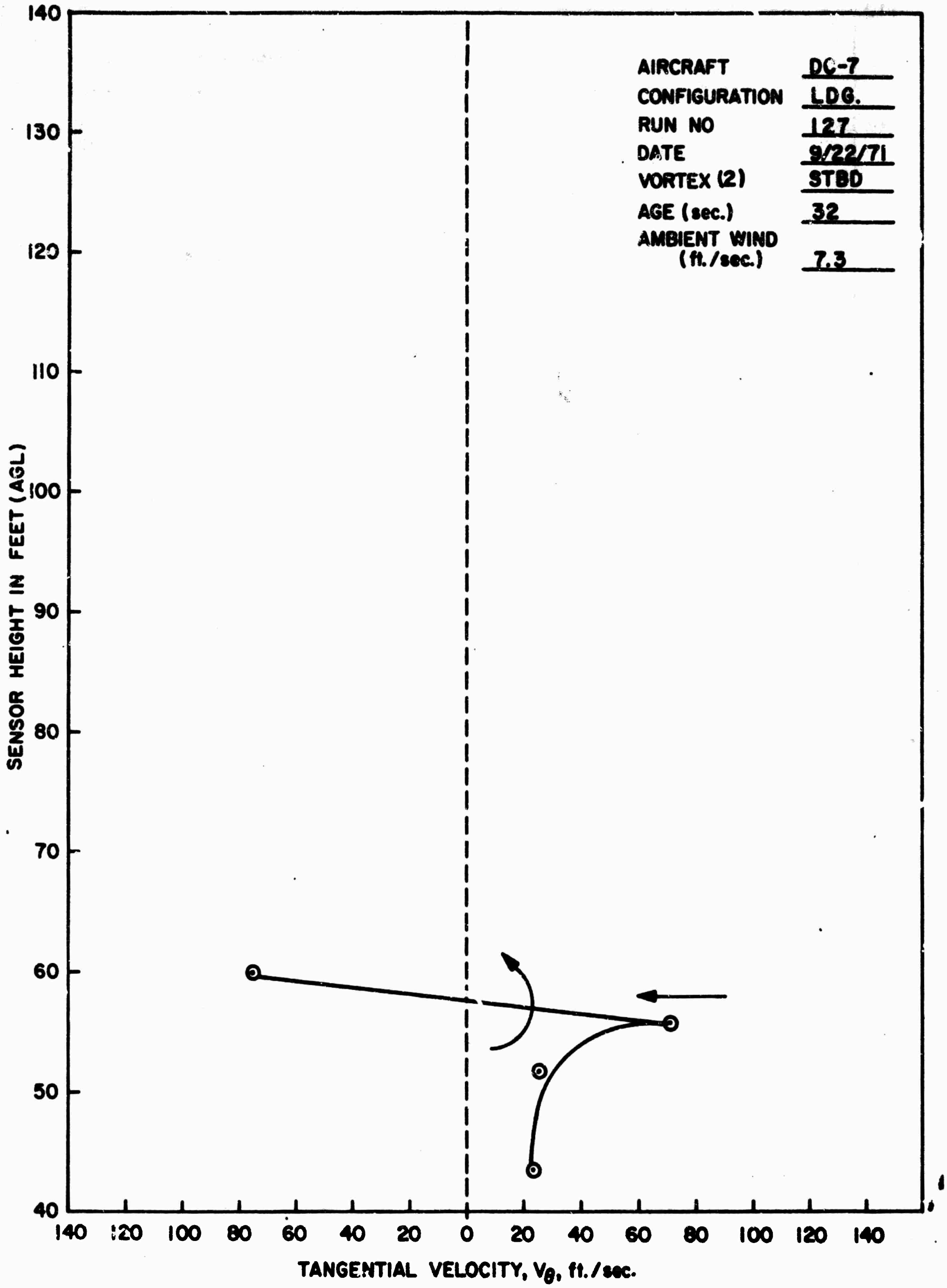

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN. NO 74
DATE 9/2/71
VORTEX (2) STBD
AGE (sec.) 30
AMBIENT WIND (ft./sec.) 9
148ft/sec
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, Vθ, ft./sec.
100
90
80
70
60
50
40
30
20
10
0
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 130
DATE 9/22/71
VORTEX (2) STBD
AGE (sec.) 30.
AMBIENT WIND (ft./sec.) 10.3
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

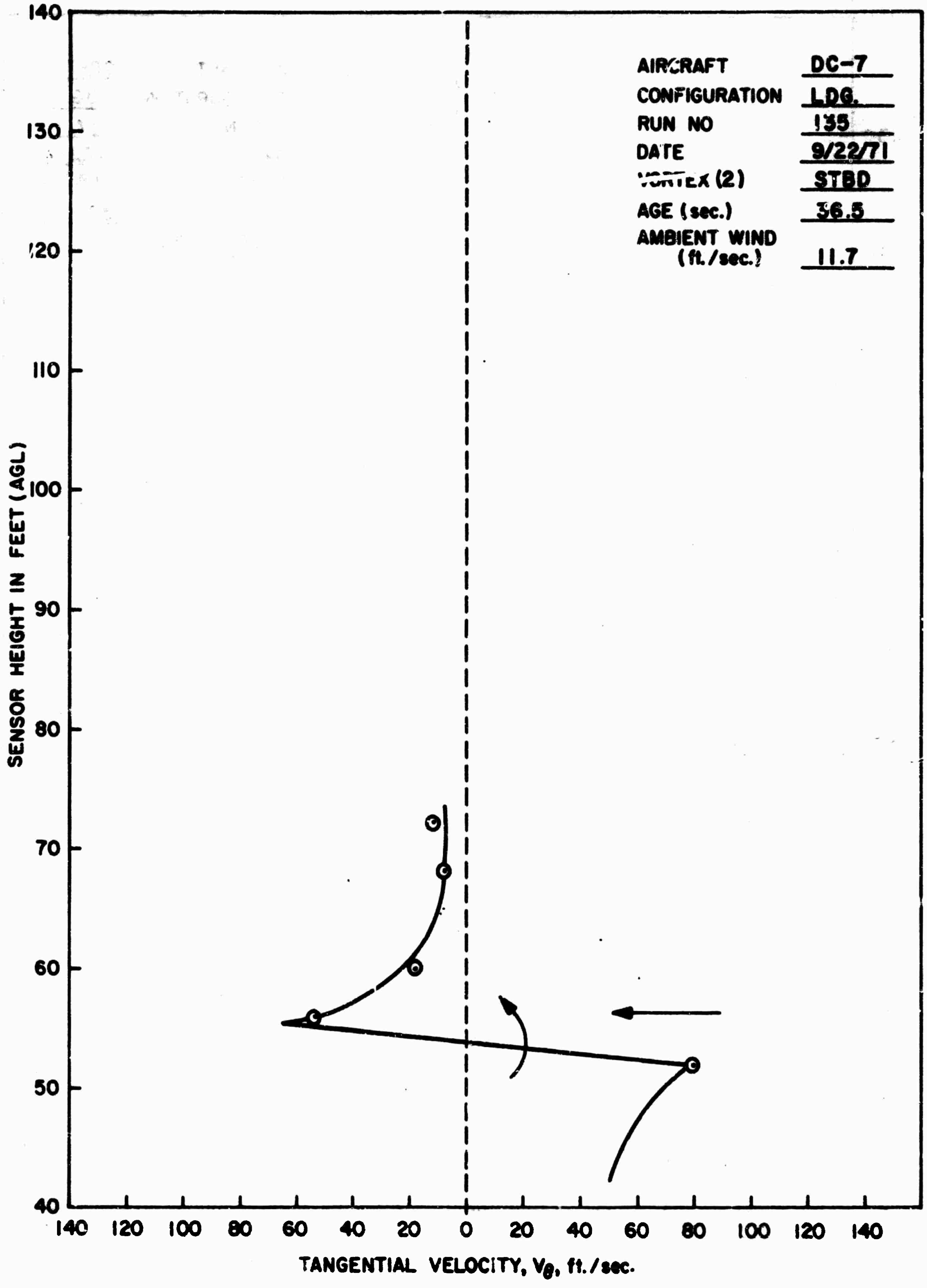

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 132
DATE 9/22/71
VORTEX (2) STBD
AGE (sec.) 30.
AMBIENT WIND (ft./sec.) 1? 7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

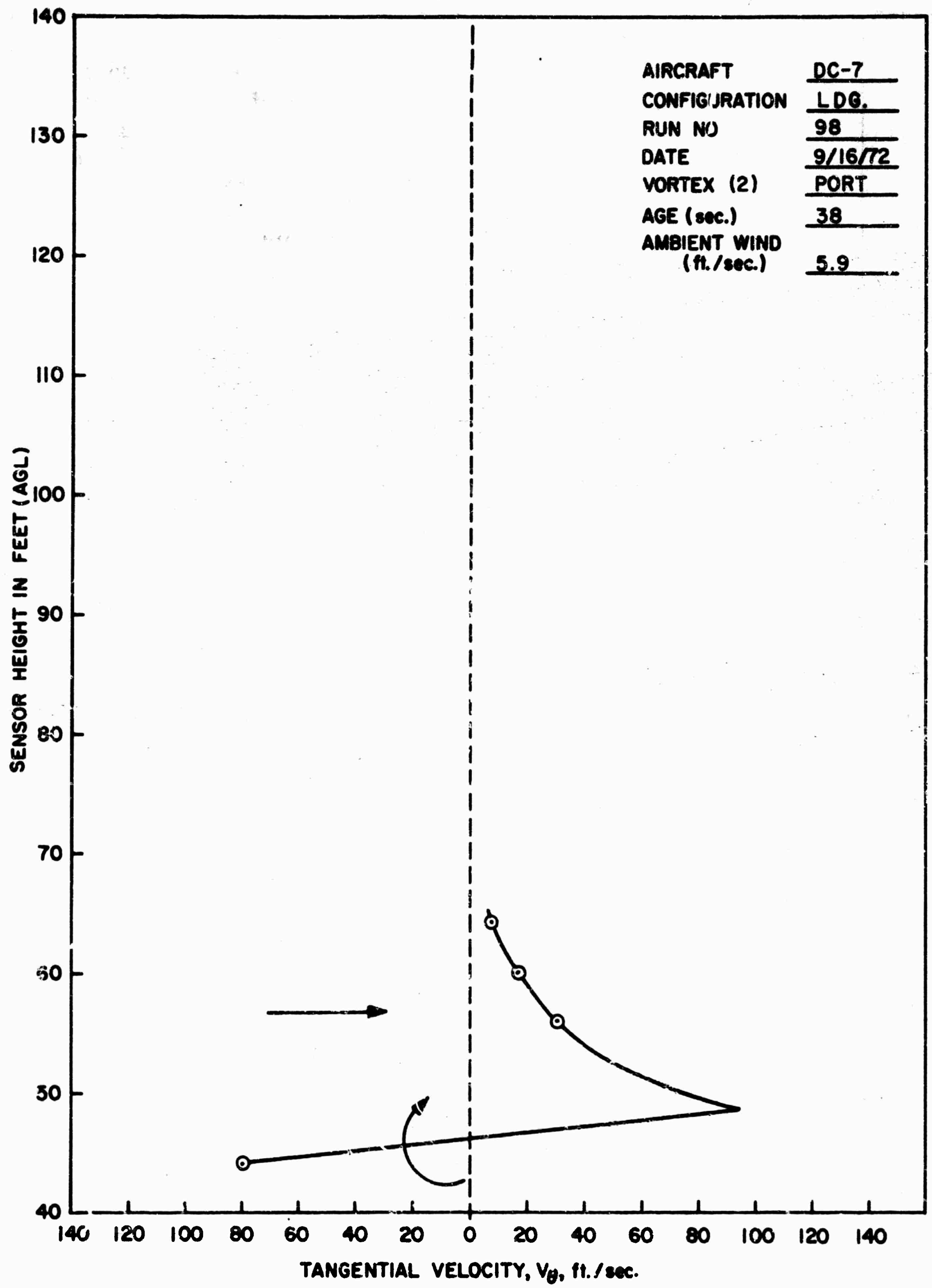

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN. NO 104
DATE 9/16/71
VORTEX (1) STBD
AGE (sec.) 31
AMBIENT WIND (ft./sec.) 2
SENSOR HEIGHT IN FEET (AGL)
100
90
80
70
60
50
40
30
20
10
0
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, Vθ, ft./sec.

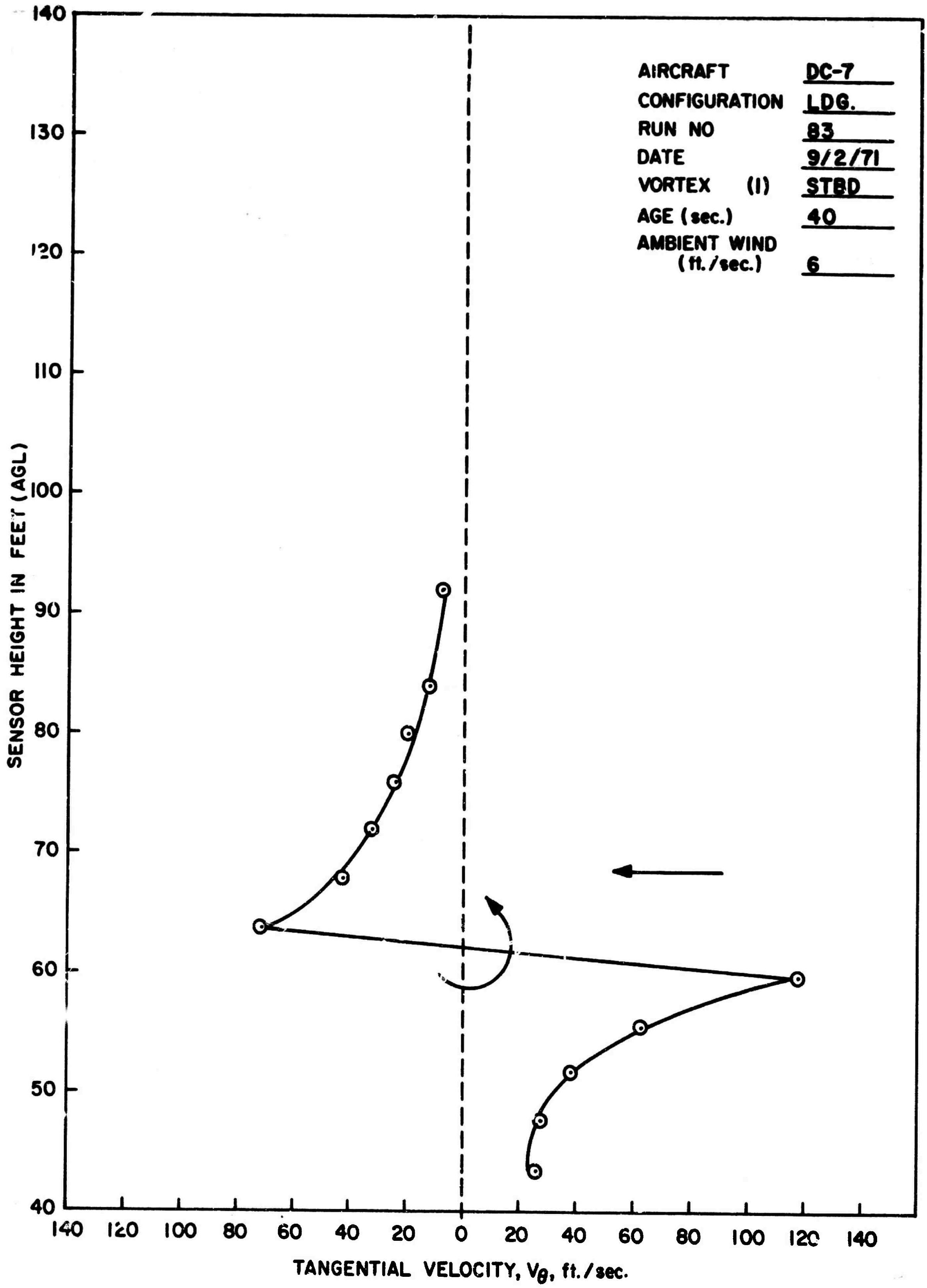

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 89
DATE 9/16/71
VORTEX (2) PORT
AGE (sec.) 32
AMBIENT WIND (ft./sec.) 7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



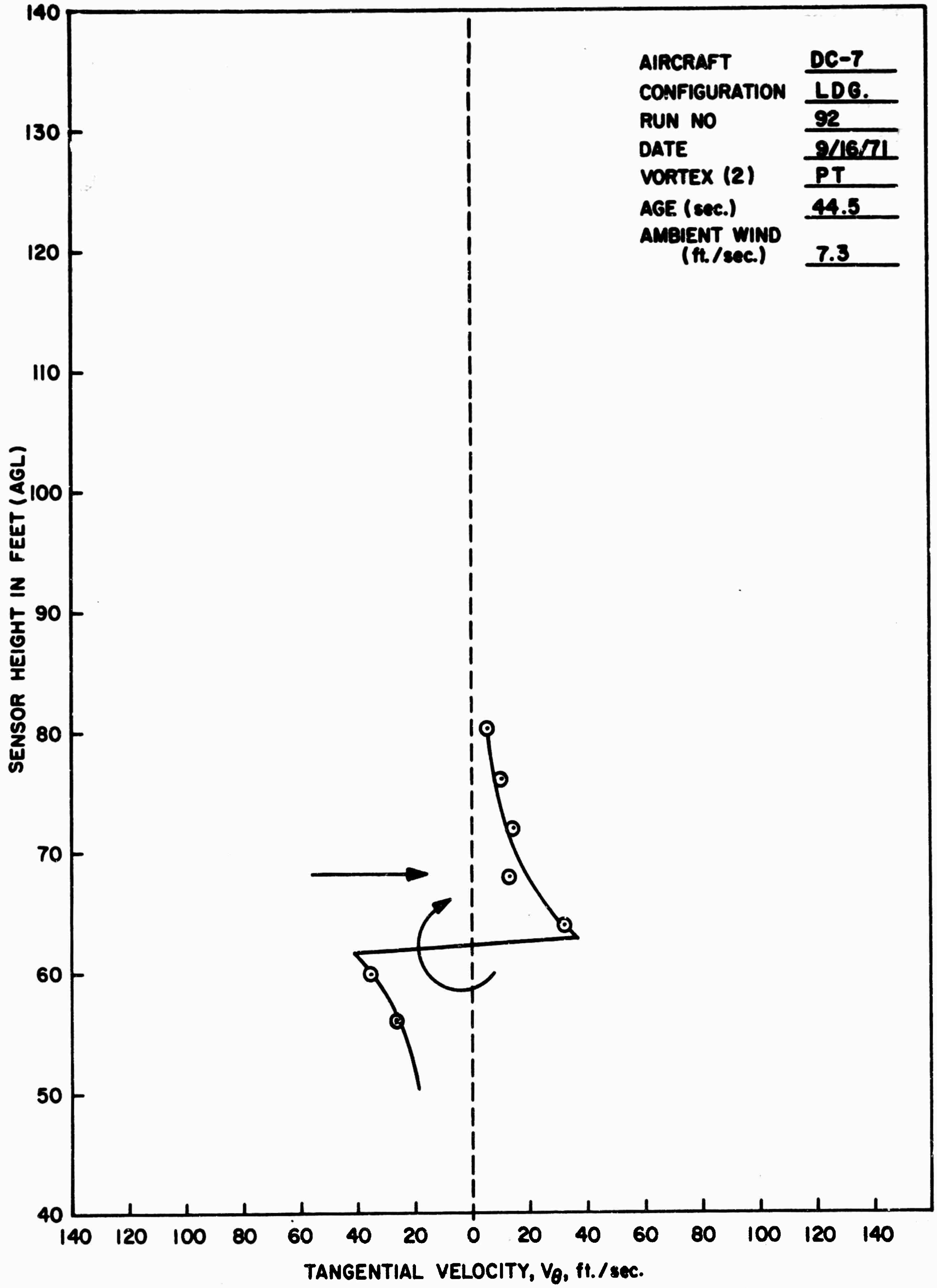
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 127
DATE 9/22/71
VORTEX (2) STBD
AGE (sec.) 32
AMBIENT WIND (ft./sec.) 7.3
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

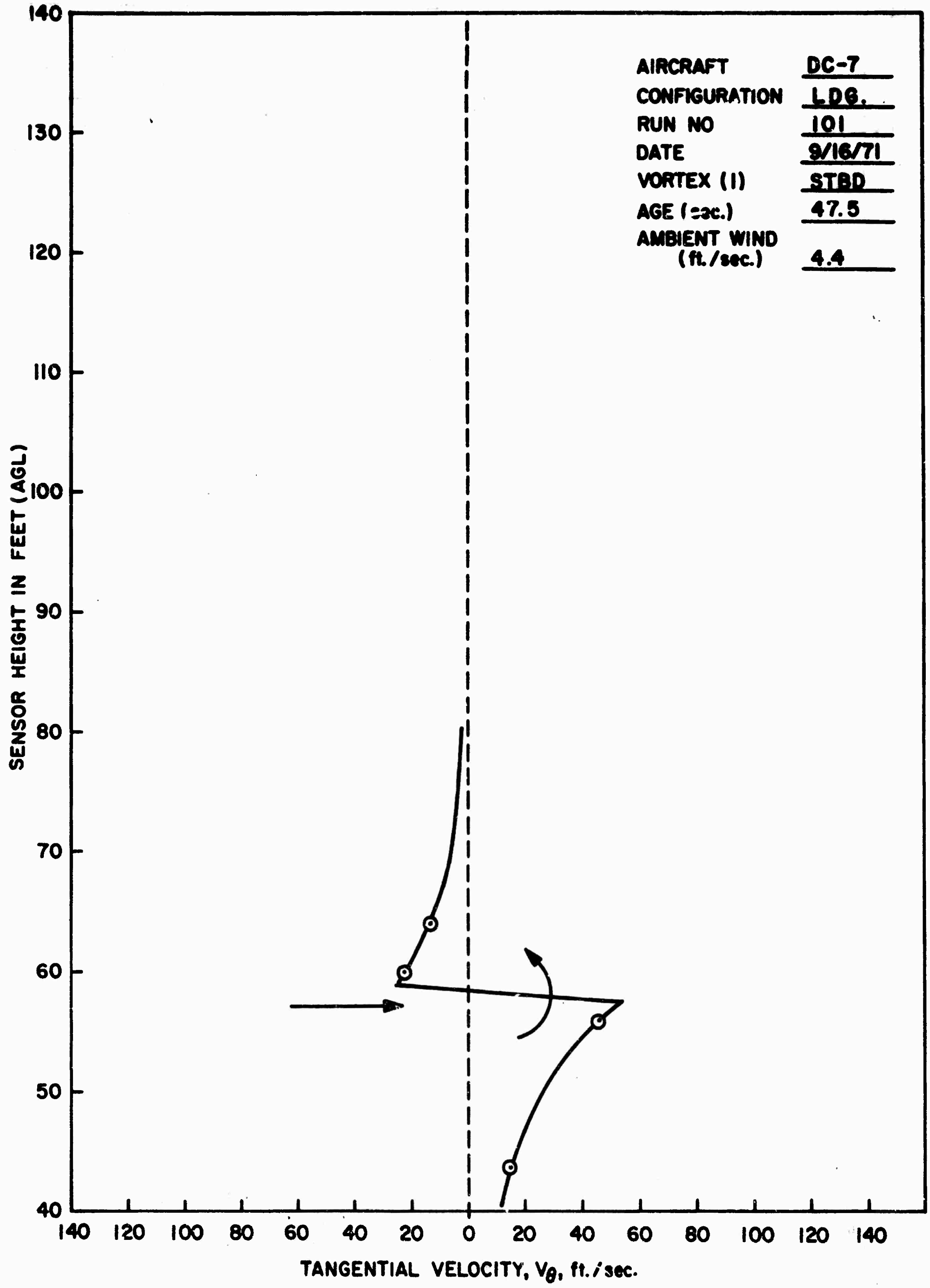

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 135
DATE 9/22/71
VORTEX (2) STBD
AGE (sec.) 36.5
AMBIENT WIND (ft./sec.) 11.7
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.


AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 98
DATE 9/16/72
VORTEX (2) PORT
AGE (sec.) 38
AMBIENT WIND (ft./sec.) 5.9
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.



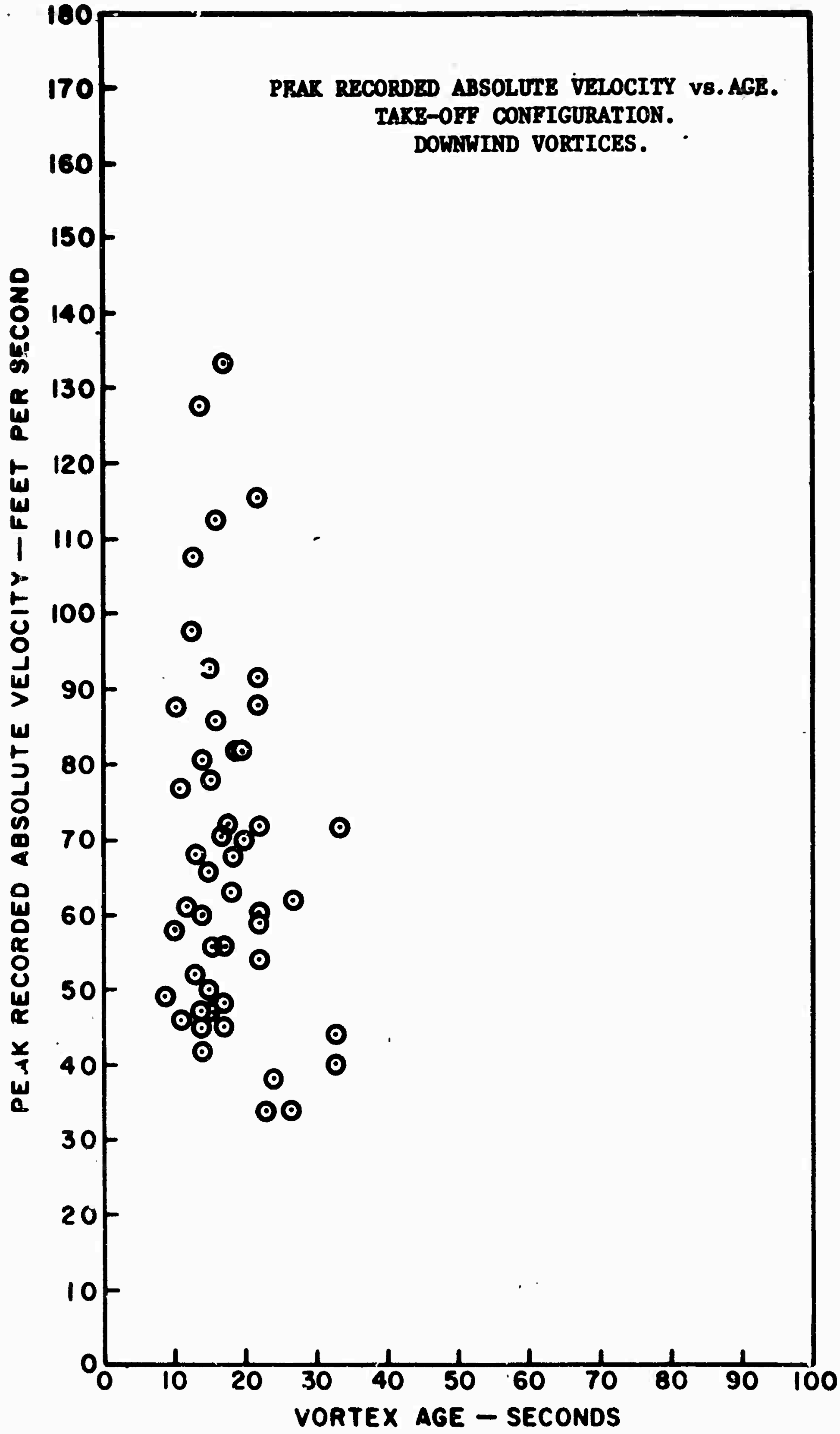
AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 83
DATE 9/2/71
VORTEX (1) STBD
AGE (sec.) 40
AMBIENT WIND (ft./sec.) 6
SENSOR HEIGHT IN FEET (AGL)
TANGENTIAL VELOCITY, V_θ, ft./sec.
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140

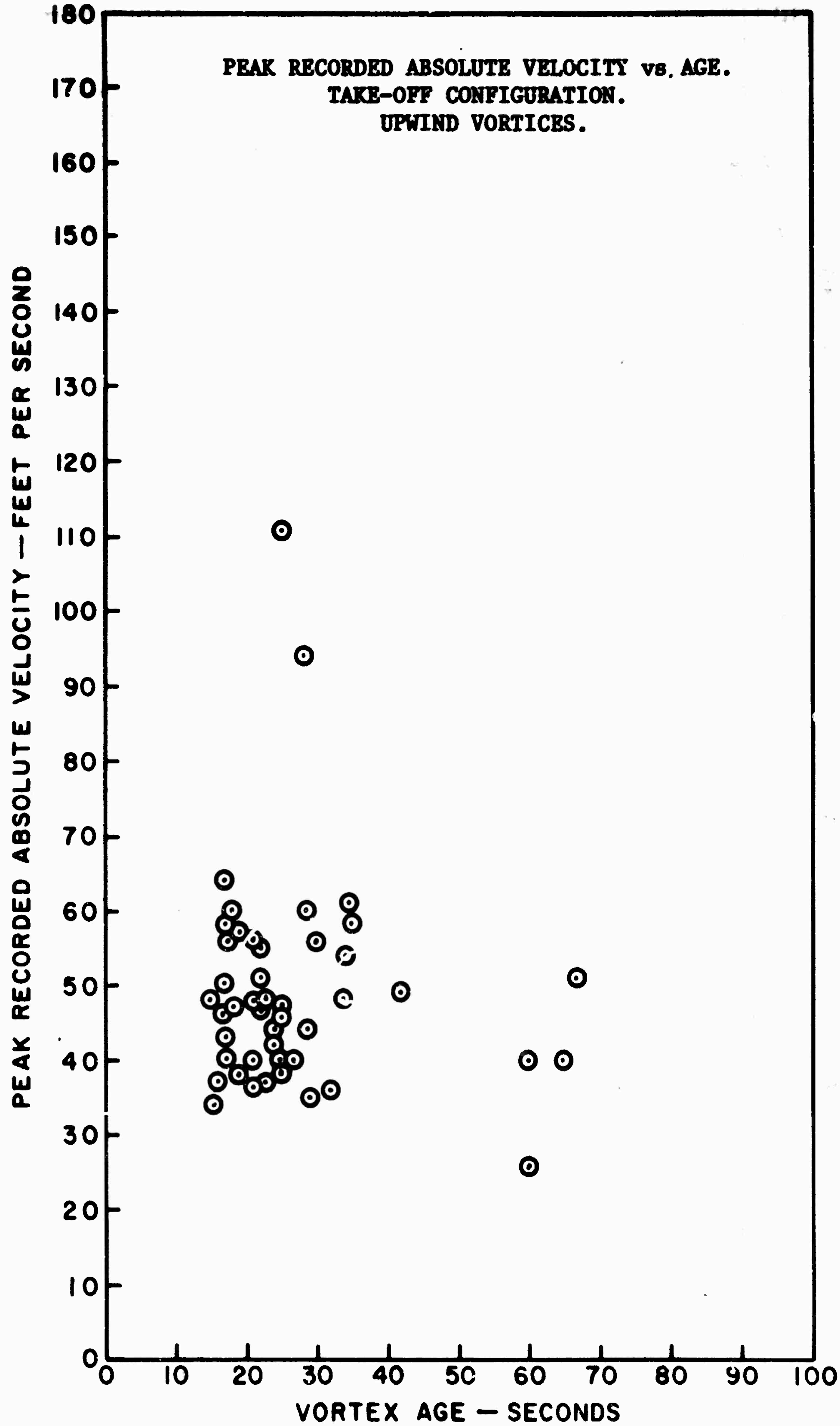

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 92
DATE 9/16/71
VORTEX (2) PT
AGE (sec.) 44.5
AMBIENT WIND (ft./sec.) 7.3
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

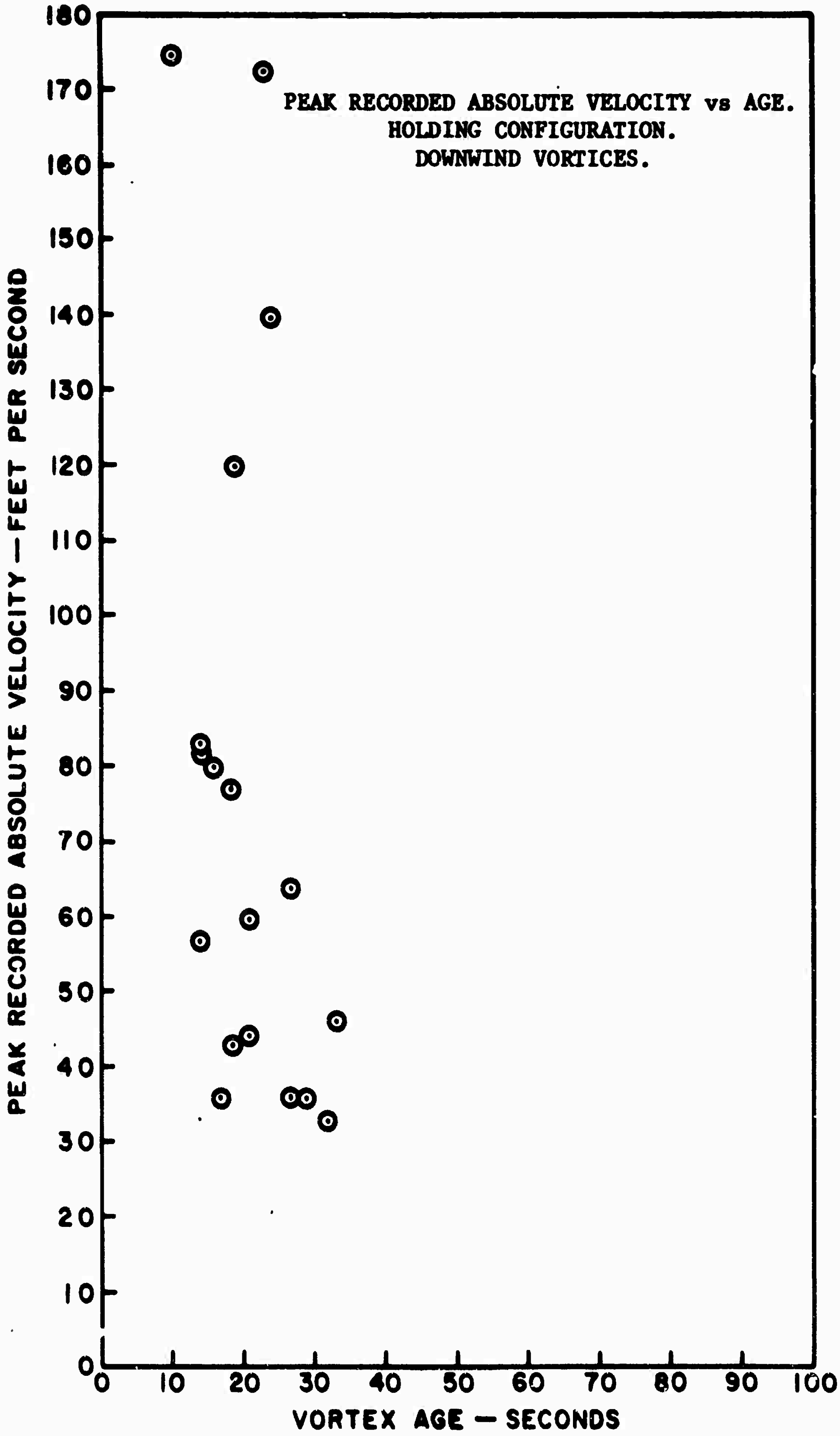

AIRCRAFT DC-7
CONFIGURATION LDG.
RUN NO 101
DATE 9/16/71
VORTEX (1) STBD
AGE (sec.) 47.5
AMBIENT WIND (ft./sec.) 4.4
SENSOR HEIGHT IN FEET (AGL)
140
130
120
110
100
90
80
70
60
50
40
140 120 100 80 60 40 20 0 20 40 60 80 100 120 140
TANGENTIAL VELOCITY, V_θ, ft./sec.

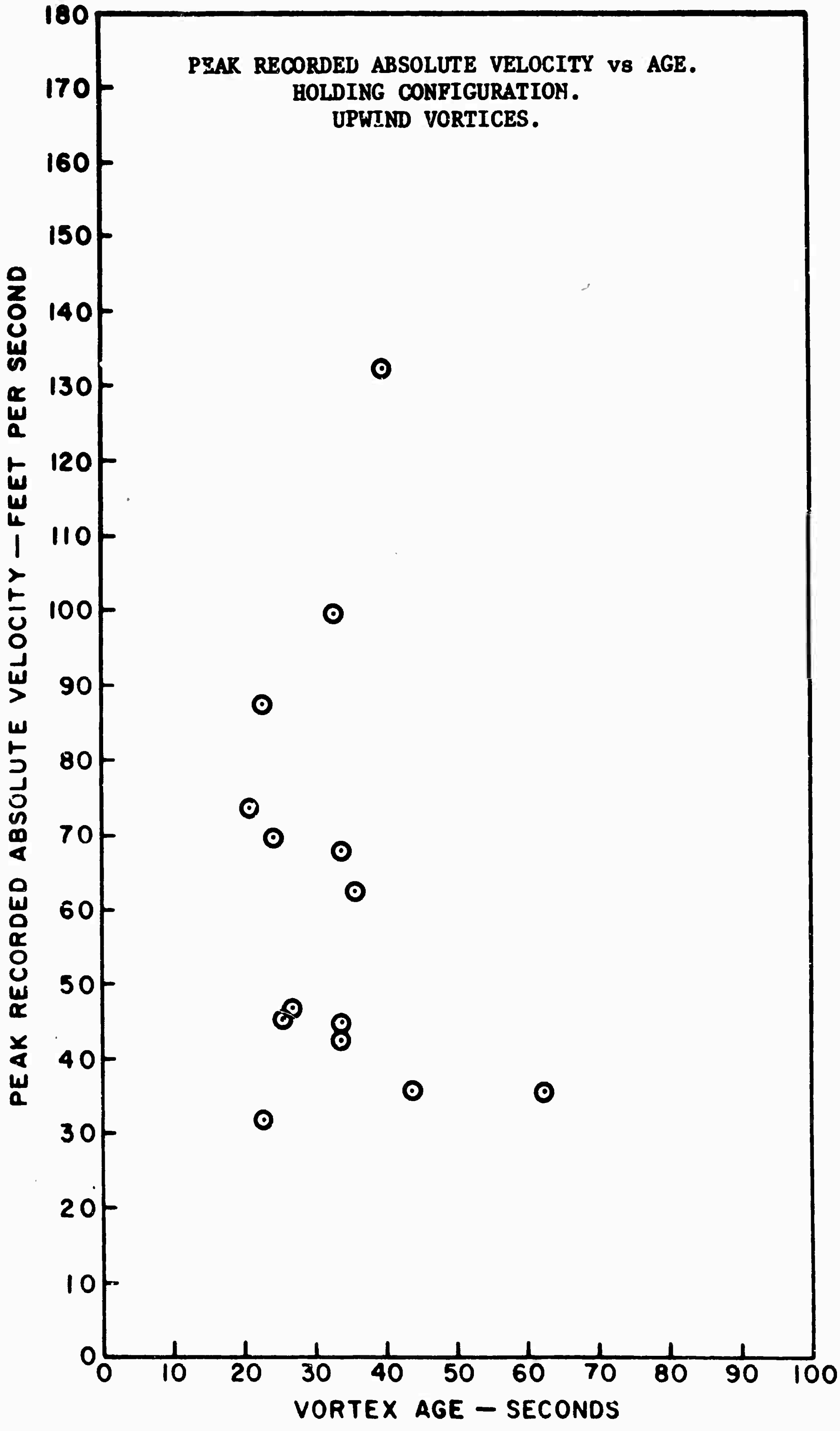
APPENDIX F

GRAPHS PRESENTING VORTEX AGE AND AMBIENT WIND VELOCITIES


PEAK RECORDED ABSOLUTE VELOCITY vs. AGE.
TAKE-OFF CONFIGURATION.
DOWNWIND VORTICES.
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
VORTEX AGE — SECONDS
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180


PEAK RECORDED ABSOLUTE VELOCITY vs. AGE.
TAKE-OFF CONFIGURATION.
UPWIND VORTICES.
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
90
100
VORTEX AGE — SECONDS


PEAK RECORDED ABSOLUTE VELOCITY vs AGE.
HOLDING CONFIGURATION.
DOWNWIND VORTICES.
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
0
10
20
30
40
50
60
70
80
90
100
VORTEX AGE — SECONDS


PEAK RECORDED ABSOLUTE VELOCITY vs AGE.
HOLDING CONFIGURATION.
UPWIND VORTICES.
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
10
20
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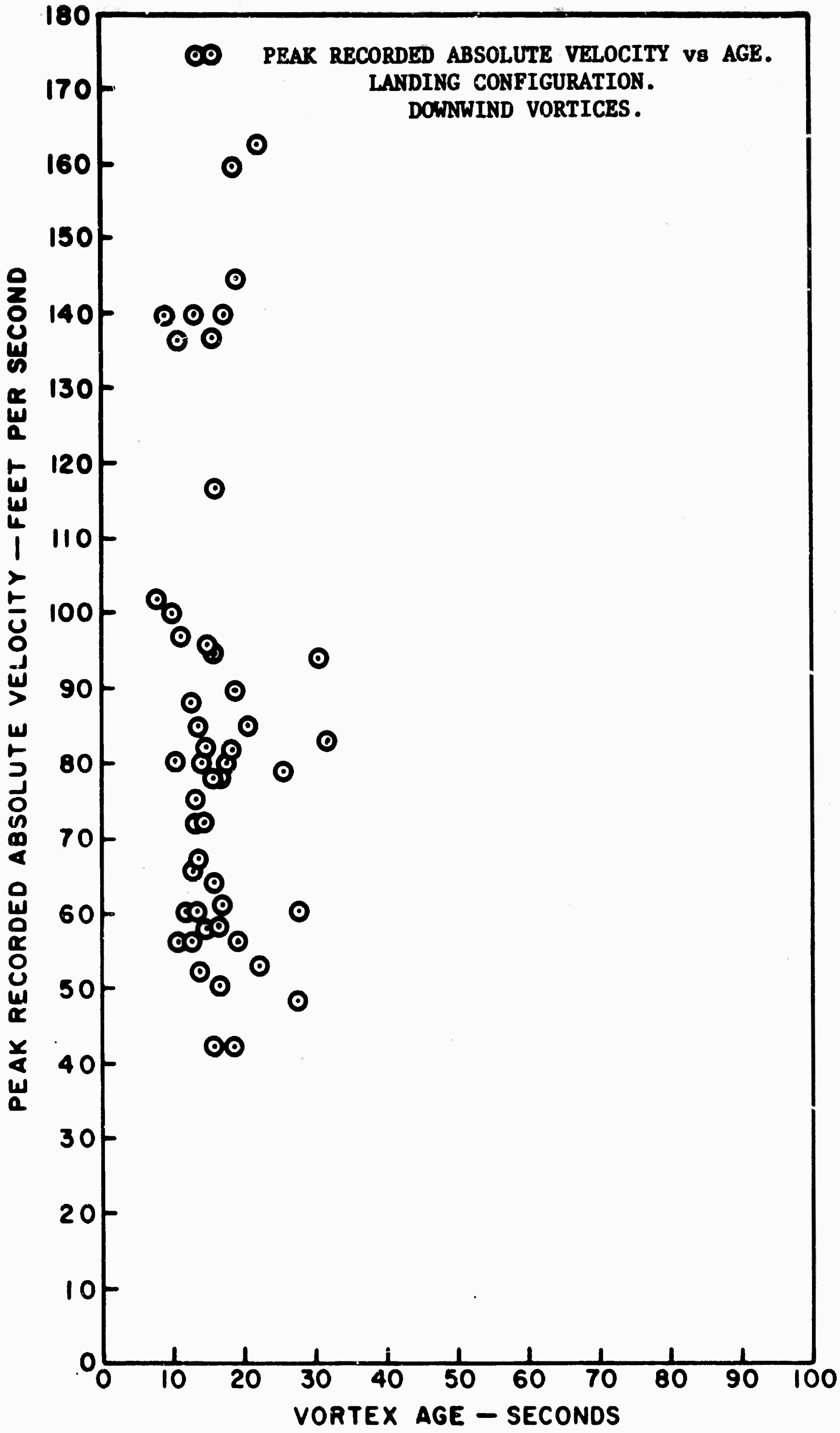
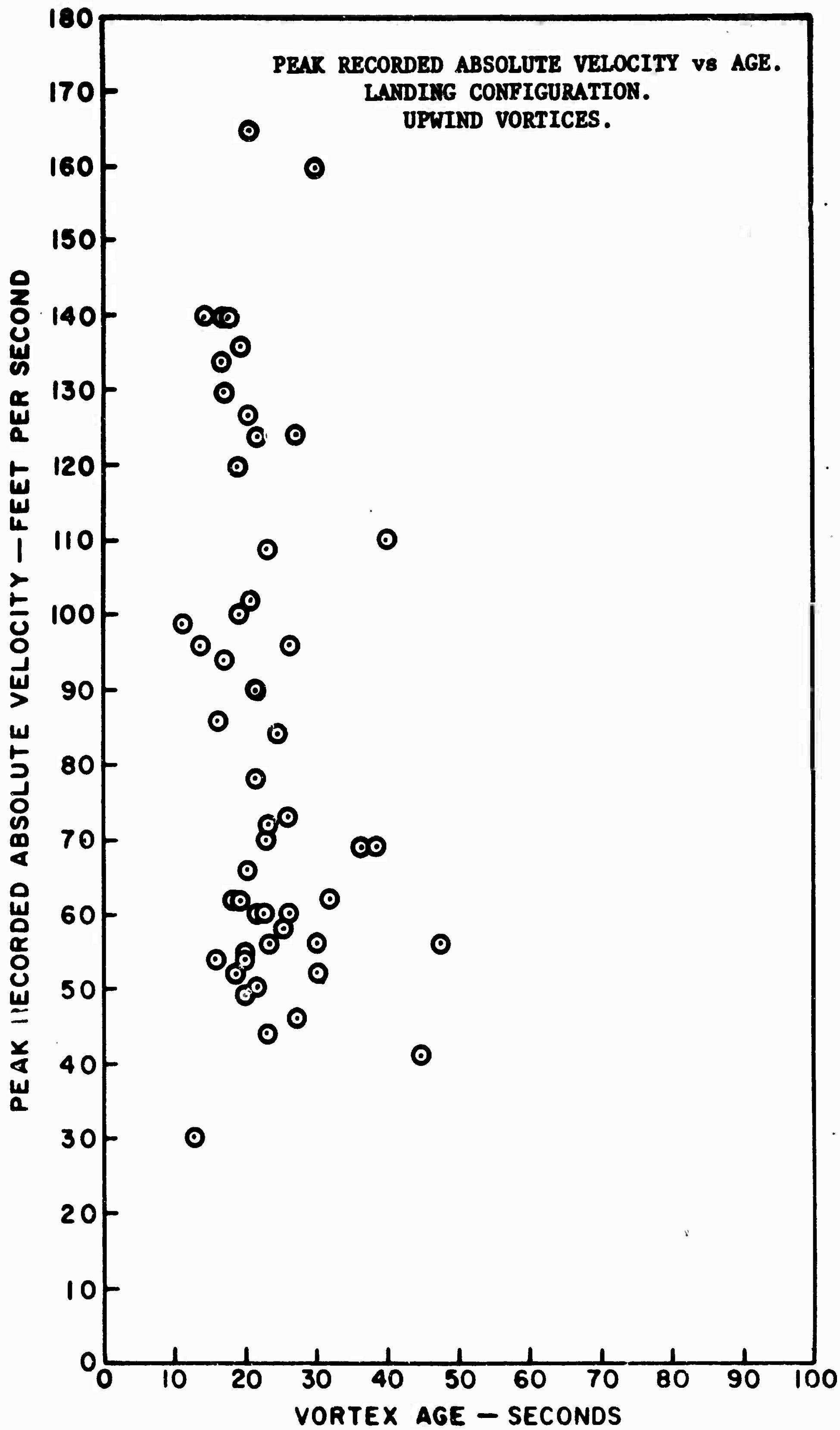
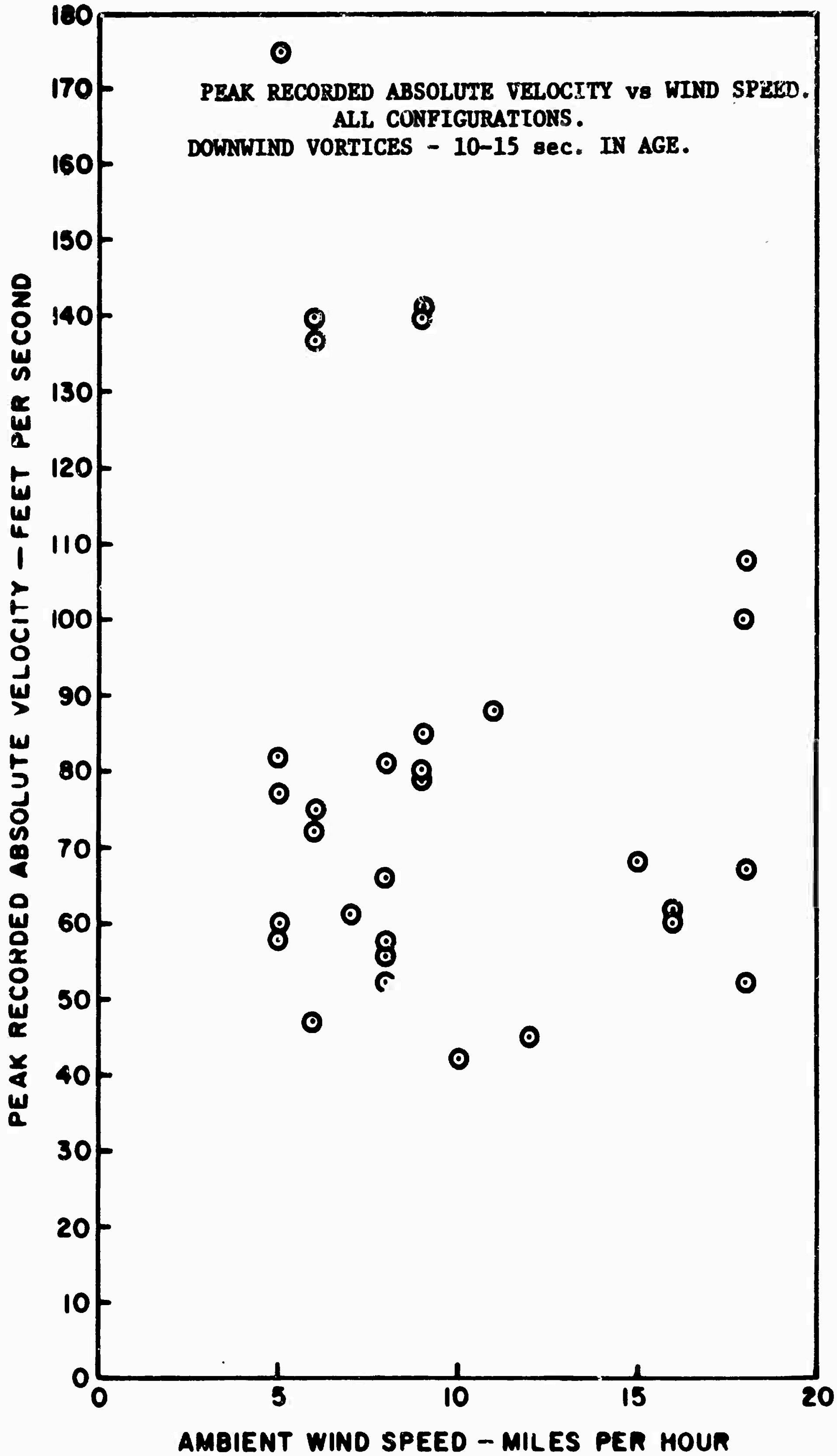
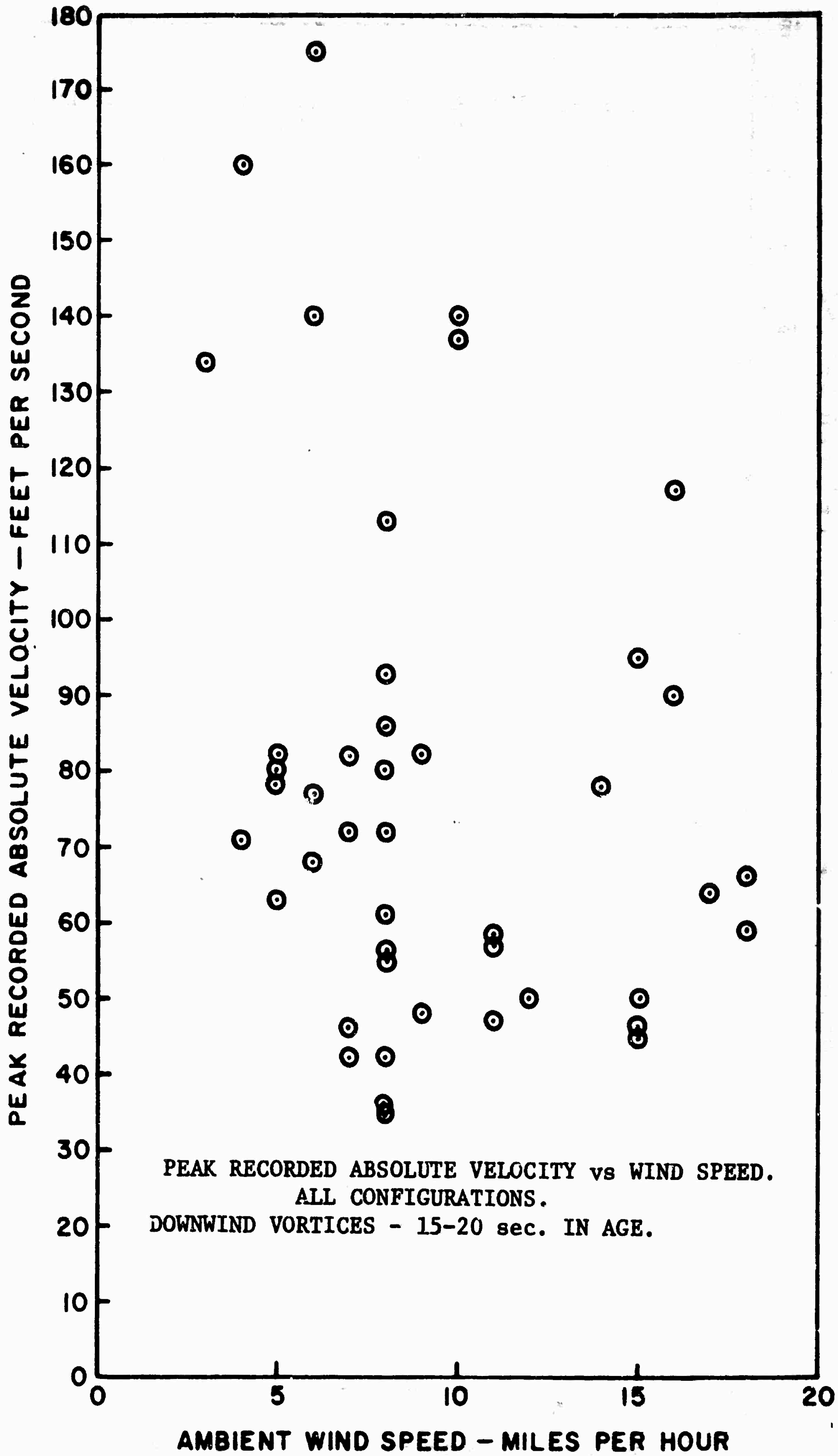
60
70
80
90
100
VORTEX AGE — SECONDS

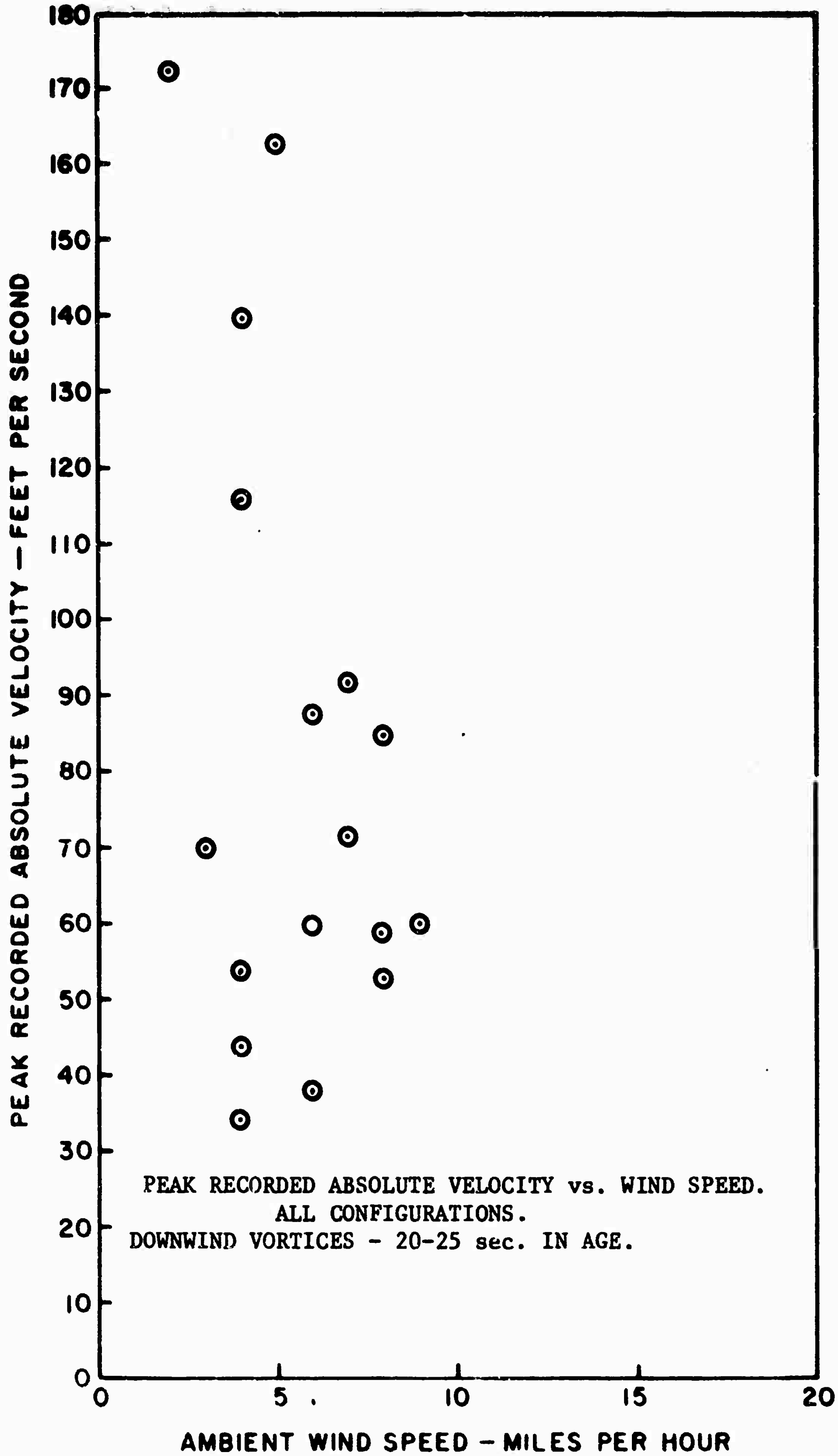


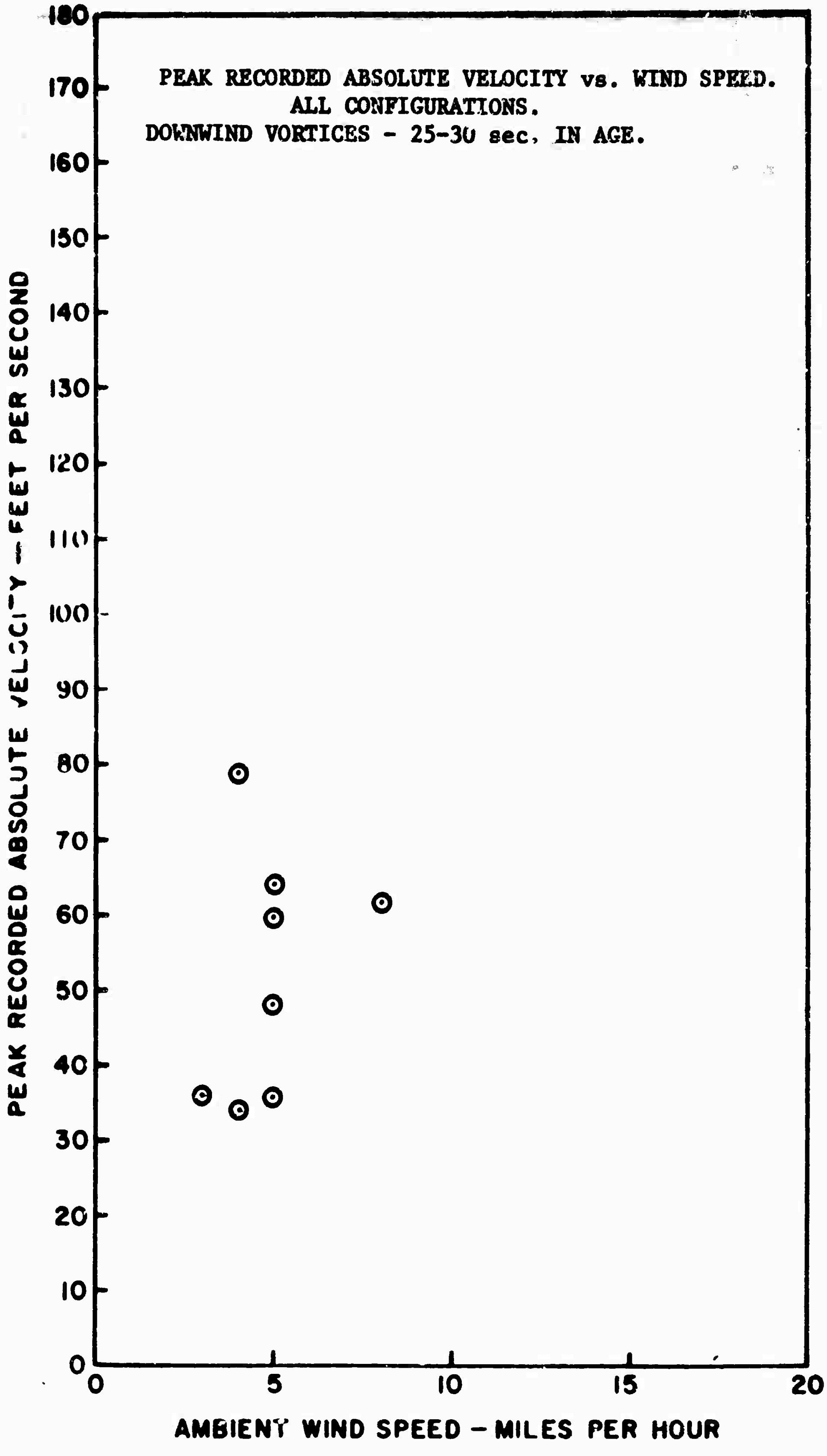
PEAK RECORDED ABSOLUTE VELOCITY vs AGE.
LANDING CONFIGURATION.
DOWNWIND VORTICES.
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
VORTEX AGE — SECONDS
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
0
10
20
30
40
50
60
70
80
90
100

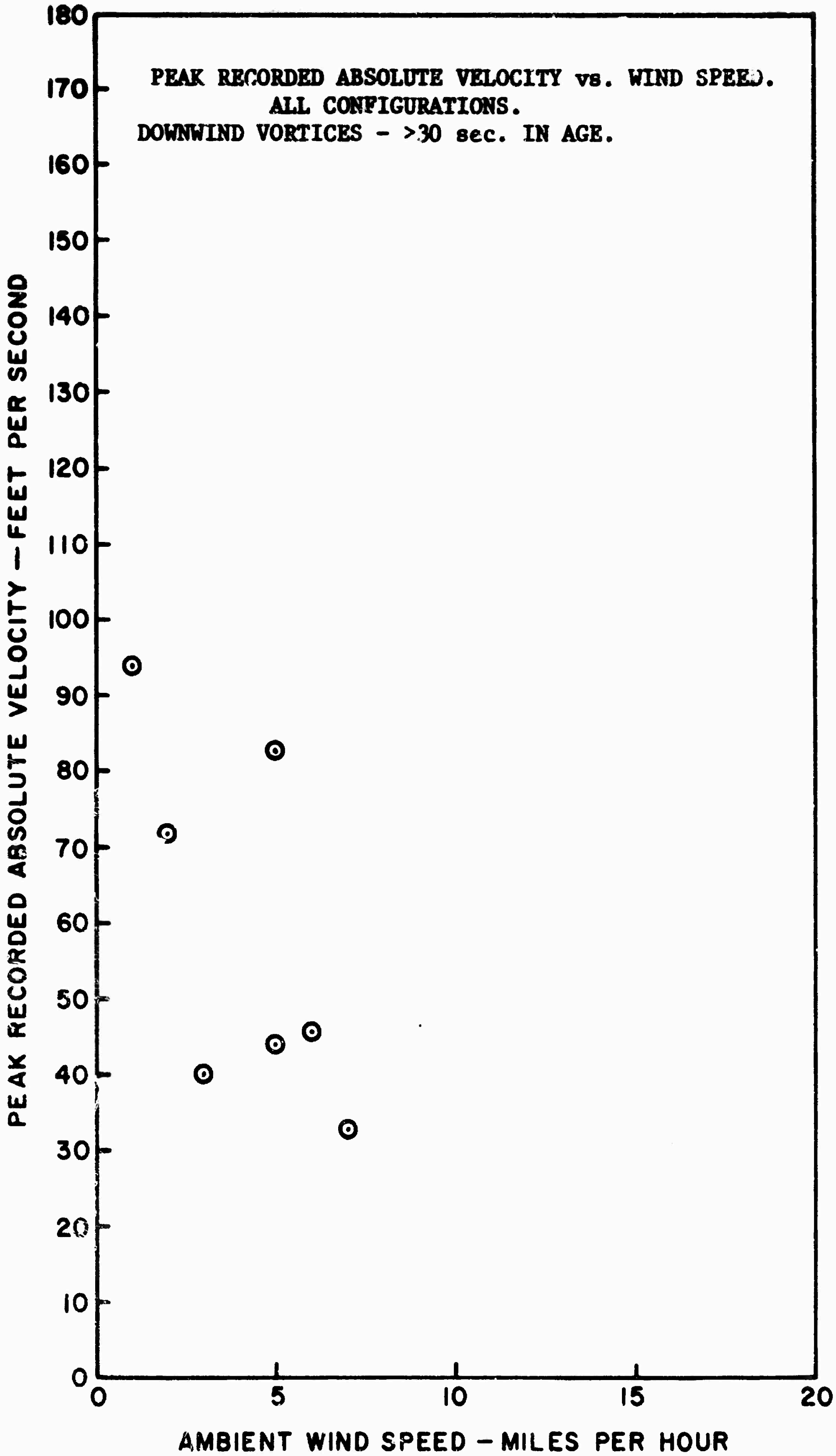

PEAK RECORDED ABSOLUTE VELOCITY vs AGE.
LANDING CONFIGURATION.
UPWIND VORTICES.
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
VORTEX AGE — SECONDS
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180

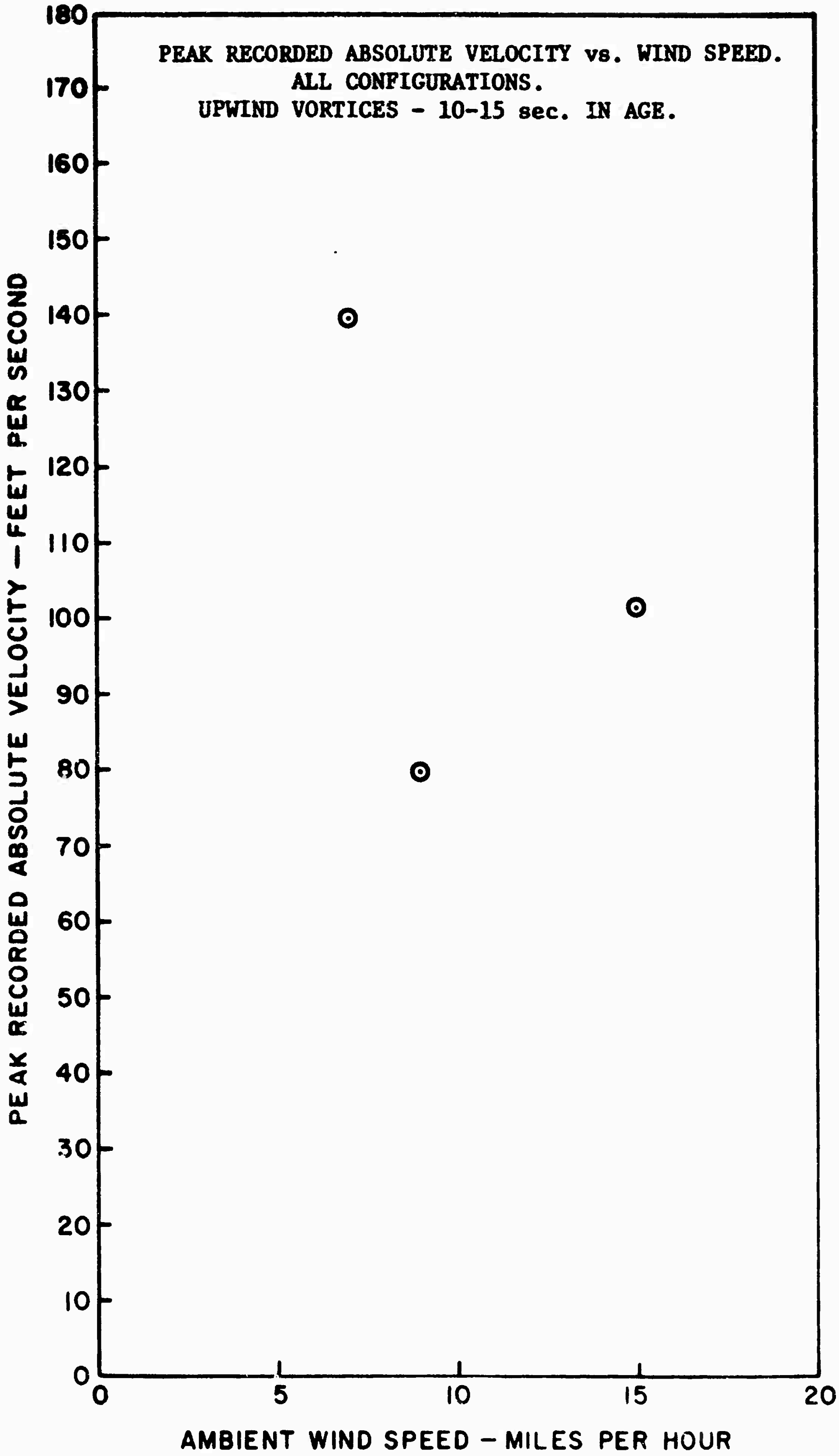

PEAK RECORDED ABSOLUTE VELOCITY vs WIND SPEED.
ALL CONFIGURATIONS.
DOWNWIND VORTICES - 10-15 sec. IN AGE.
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
0
5
10
15
20
AMBIENT WIND SPEED — MILES PER HOUR

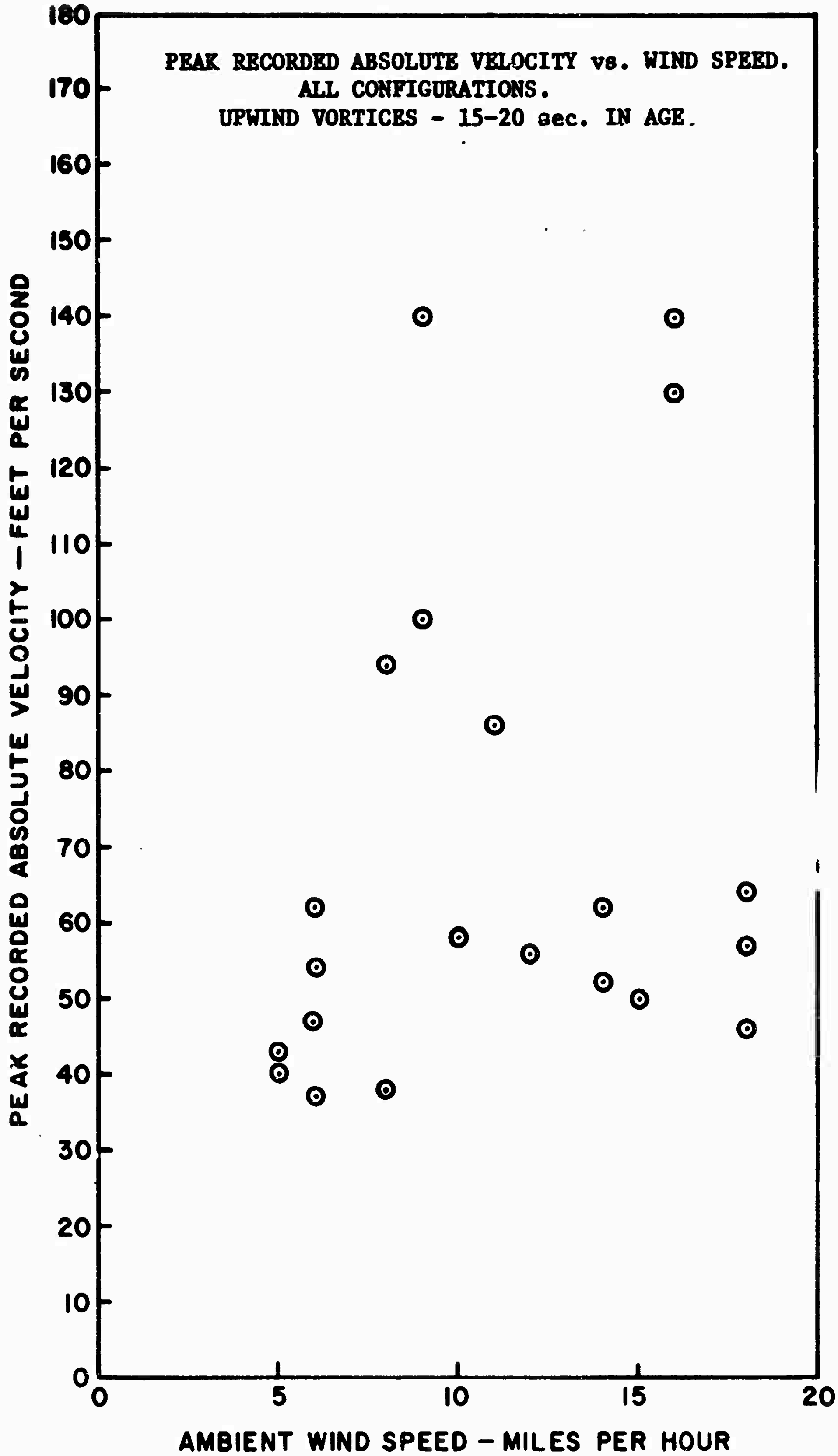

180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
AMBIENT WIND SPEED — MILES PER HOUR
PEAK RECORDED ABSOLUTE VELOCITY vs WIND SPEED.
ALL CONFIGURATIONS.
DOWNWIND VORTICES - 15-20 sec. IN AGE.

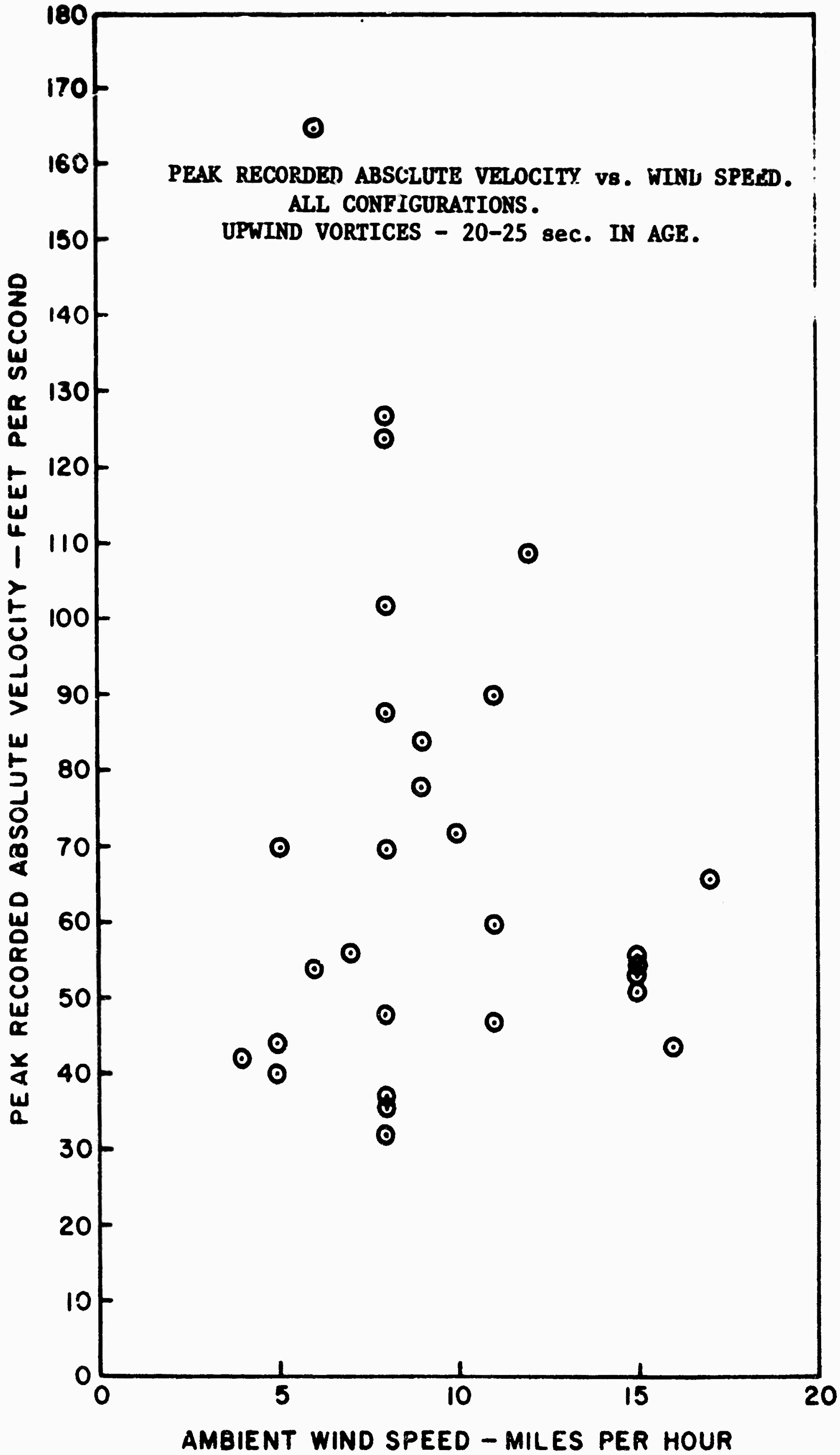

PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
0
5
10
15
20
AMBIENT WIND SPEED — MILES PER HOUR
PEAK RECORDED ABSOLUTE VELOCITY vs. WIND SPEED.
ALL CONFIGURATIONS.
DOWNWIND VORTICES - 20-25 sec. IN AGE.


PEAK RECORDED ABSOLUTE VELOCITY vs. WIND SPEED.
ALL CONFIGURATIONS.
DOWNWIND VORTICES - 25-30 sec. IN AGE.
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
AMBIENT WIND SPEED — MILES PER HOUR
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
0
5
10
15
20

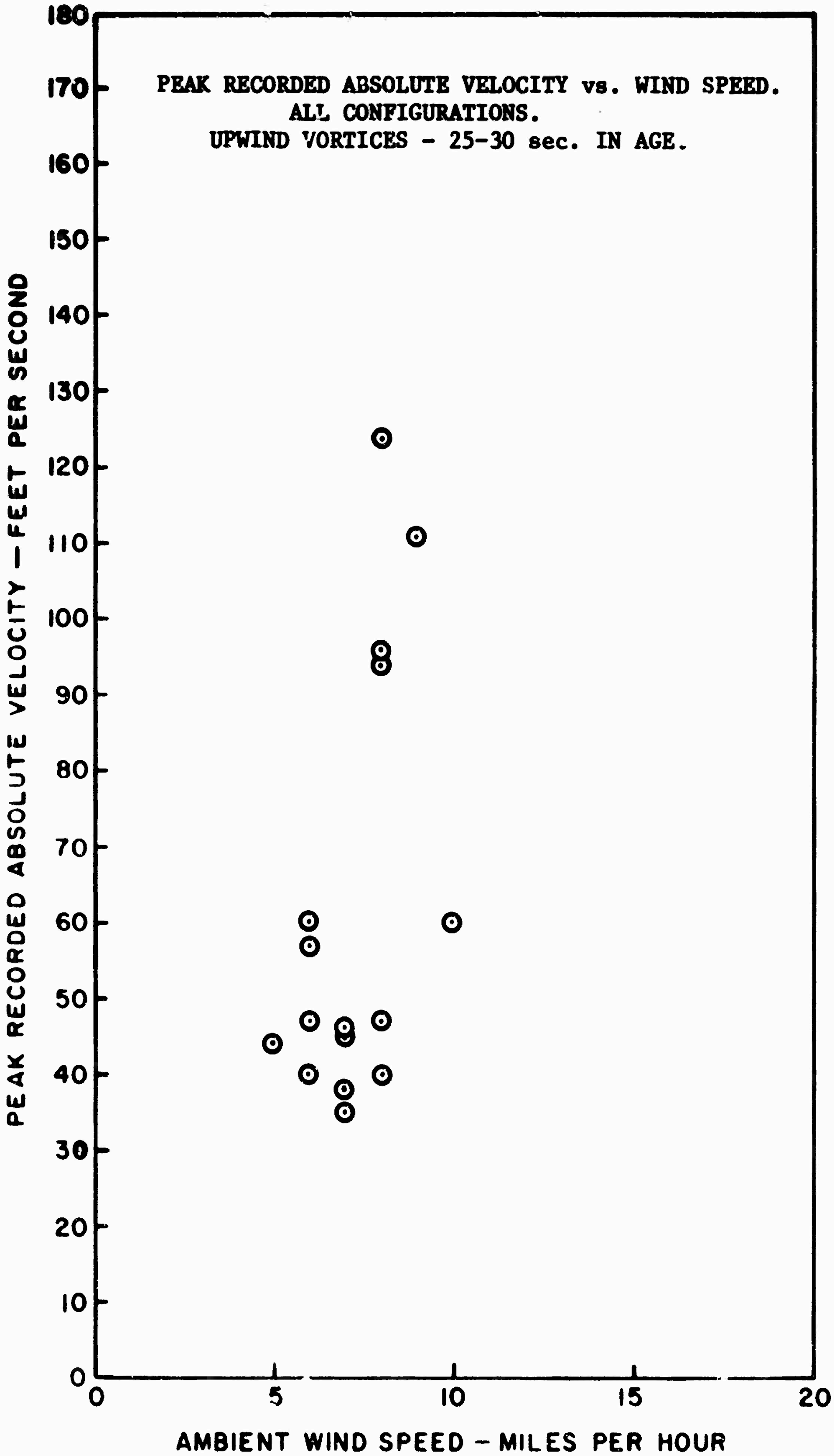

PEAK RECORDED ABSOLUTE VELOCITY vs. WIND SPEED.
ALL CONFIGURATIONS.
DOWNWIND VORTICES - >30 sec. IN AGE.
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
AMBIENT WIND SPEED — MILES PER HOUR

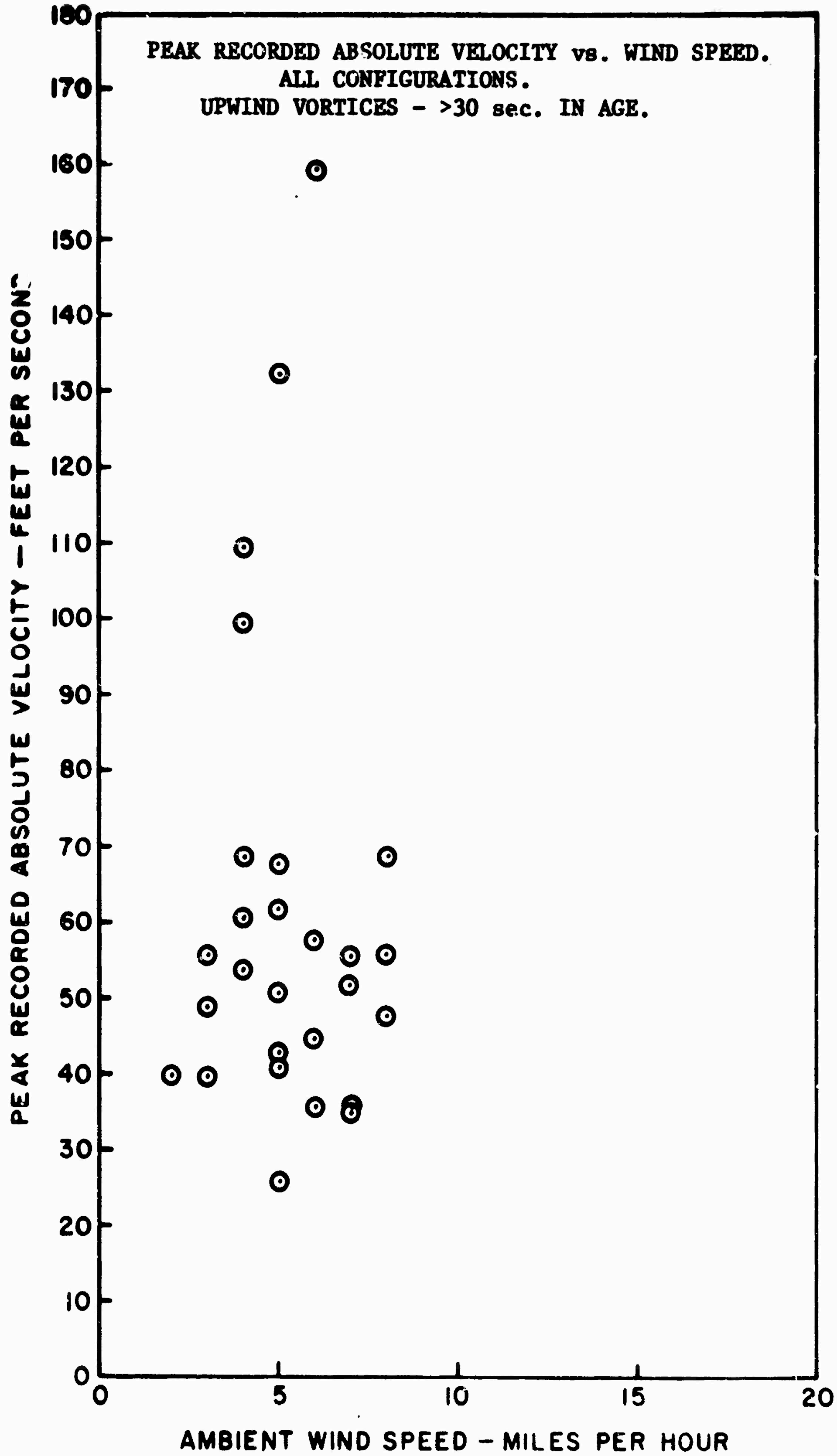

PEAK RECORDED ABSOLUTE VELOCITY vs. WIND SPEED.
ALL CONFIGURATIONS.
UPWIND VORTICES - 10-15 sec. IN AGE.
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
0
5
10
15
20
AMBIENT WIND SPEED — MILES PER HOUR

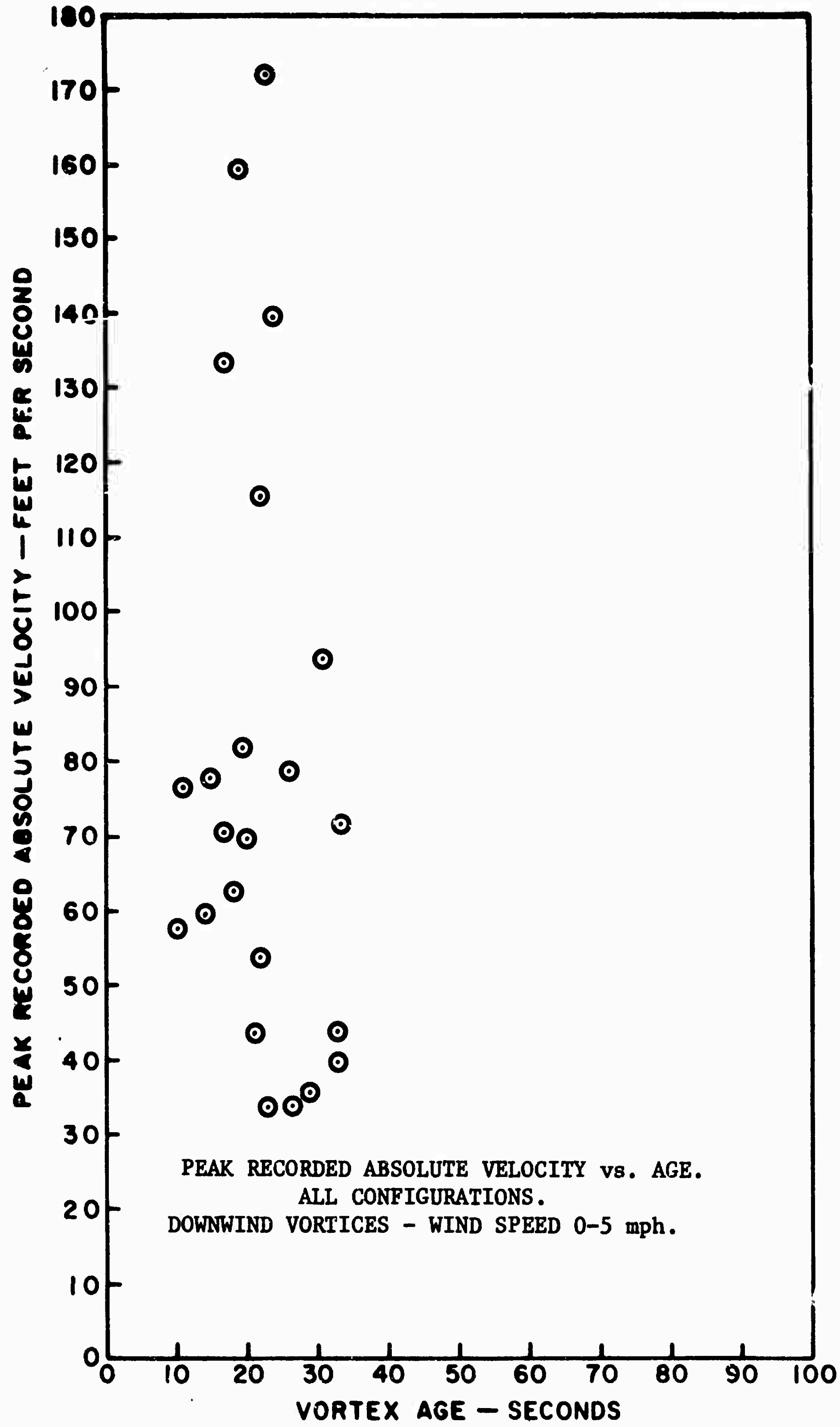

PEAK RECORDED ABSOLUTE VELOCITY vs. WIND SPEED.
ALL CONFIGURATIONS.
UPWIND VORTICES - 15-20 sec. IN AGE.
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
AMBIENT WIND SPEED — MILES PER HOUR
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
0
5
10
15
20



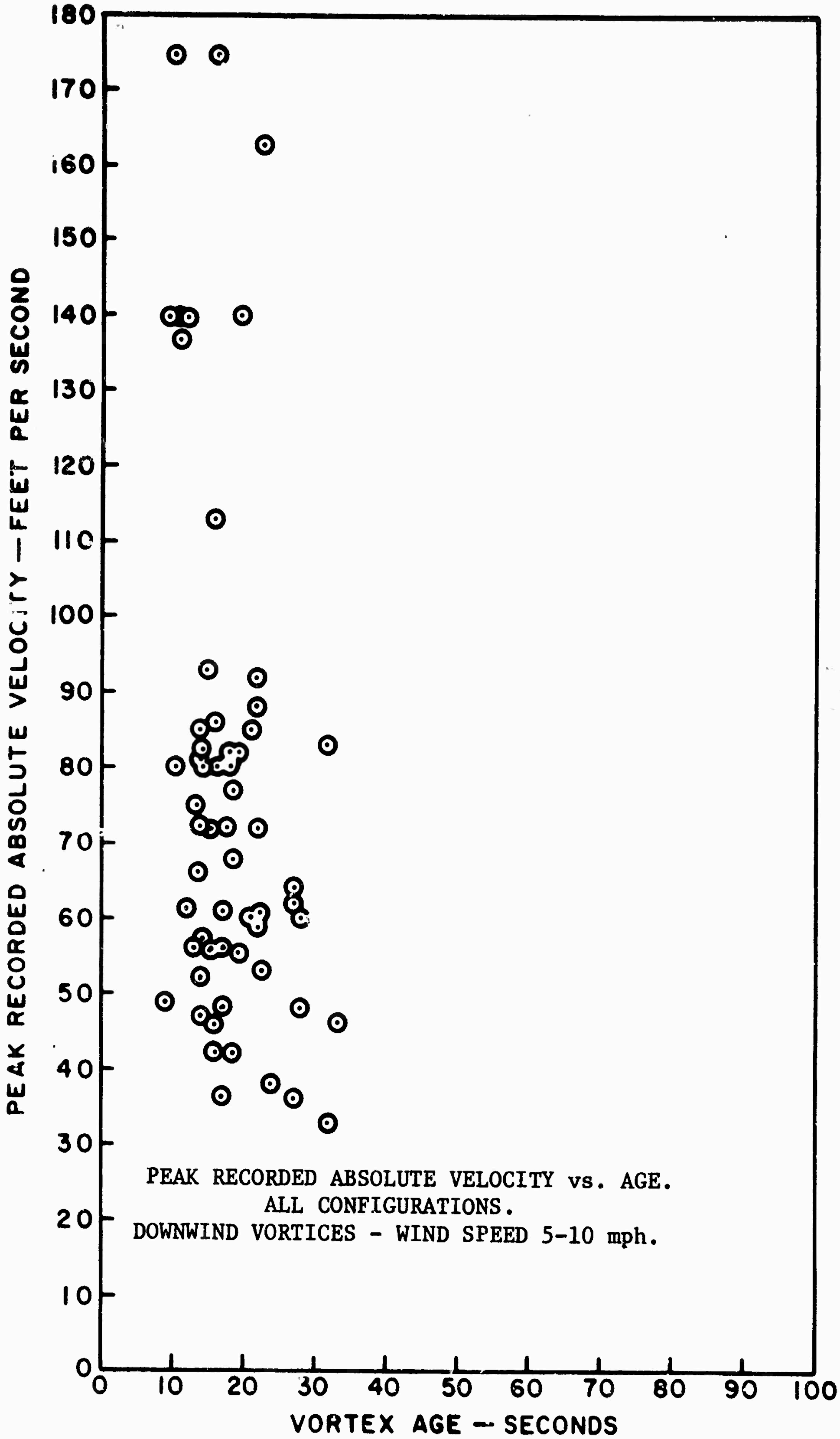
PEAK RECORDED ABSOLUTE VELOCITY vs. WIND SPEED.
ALL CONFIGURATIONS.
UPWIND VORTICES - 20-25 sec. IN AGE.
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
AMBIENT WIND SPEED — MILES PER HOUR
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
0
5
10
15
20

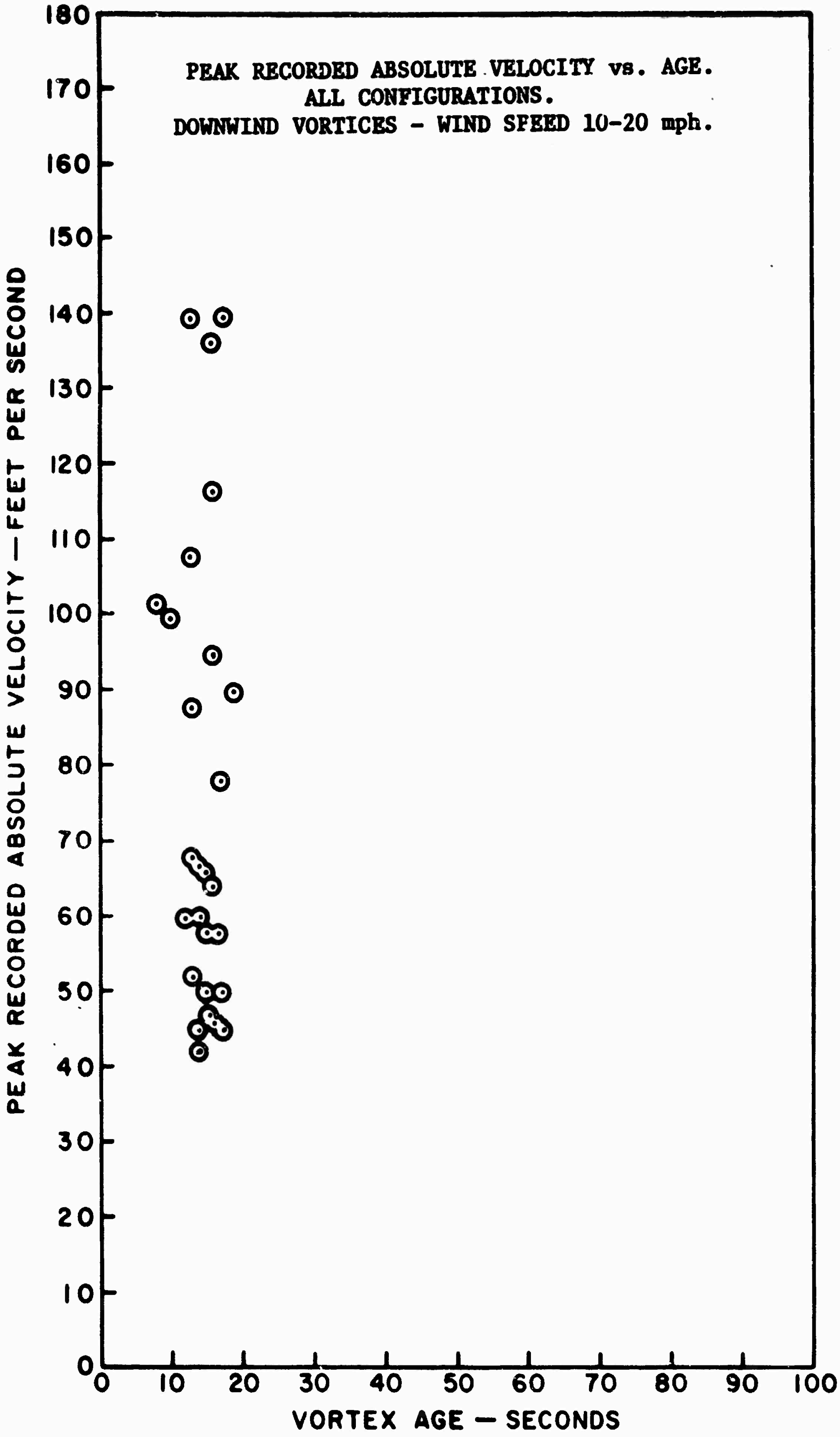

PEAK RECORDED ABSOLUTE VELOCITY vs. WIND SPEED.
ALL CONFIGURATIONS.
UPWIND VORTICES - 25-30 sec. IN AGE.
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
AMBIENT WIND SPEED – MILES PER HOUR
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
5
15


PEAK RECORDED ABSOLUTE VELOCITY vs. WIND SPEED.
ALL CONFIGURATIONS.
UPWIND VORTICES - >30 sec. IN AGE.
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECON
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
0
5
10
15
20
AMBIENT WIND SPEED — MILES PER HOUR



PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
PEAK RECORDED ABSOLUTE VELOCITY vs. AGE.
ALL CONFIGURATIONS.
DOWNWIND VORTICES - WIND SPEED 0-5 mph.
0
10
20
30
40
50
60
70
80
90
100
VORTEX AGE — SECONDS


PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
VORTEX AGE — SECONDS
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
0
10
20
30
40
50
60
70
80
90
100
PEAK RECORDED ABSOLUTE VELOCITY vs. AGE.
ALL CONFIGURATIONS.
DOWNWIND VORTICES - WIND SPEED 5-10 mph.


PEAK RECORDED ABSOLUTE VELOCITY vs. AGE.
ALL CONFIGURATIONS.
DOWNWIND VORTICES - WIND SPEED 10-20 mph.
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
VORTEX AGE — SECONDS
0
10
20
30
40
50
60
70
80
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120
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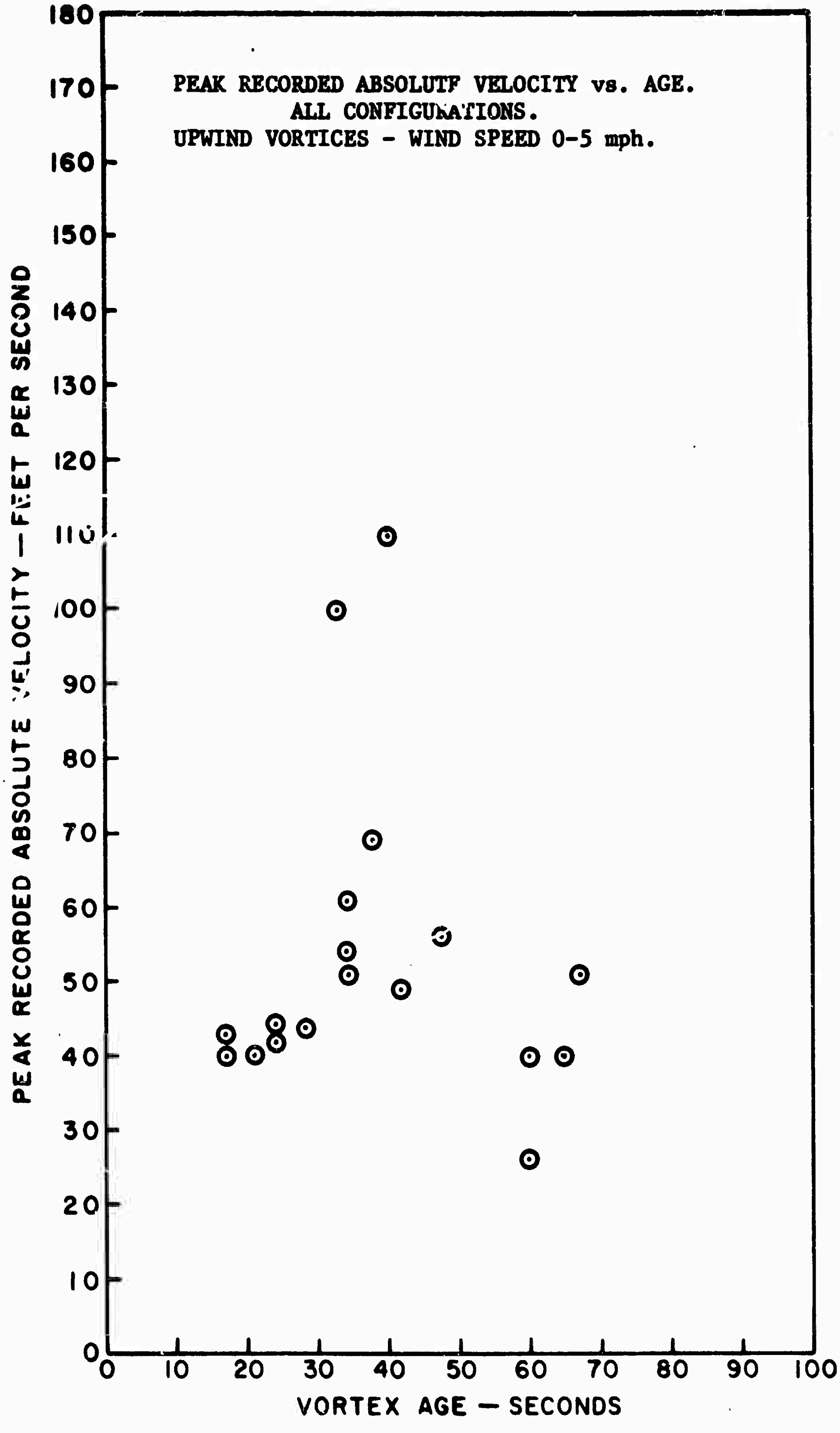
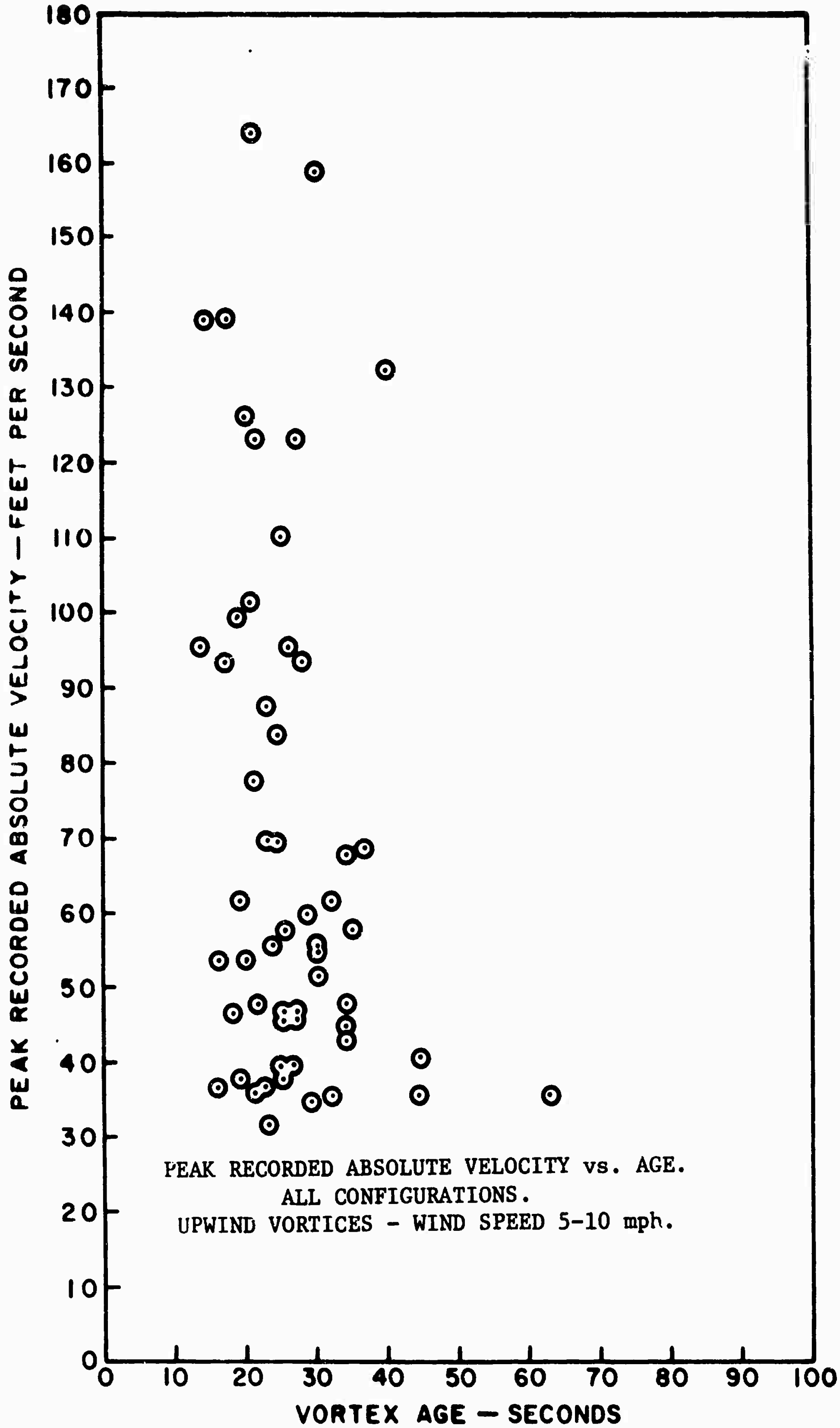
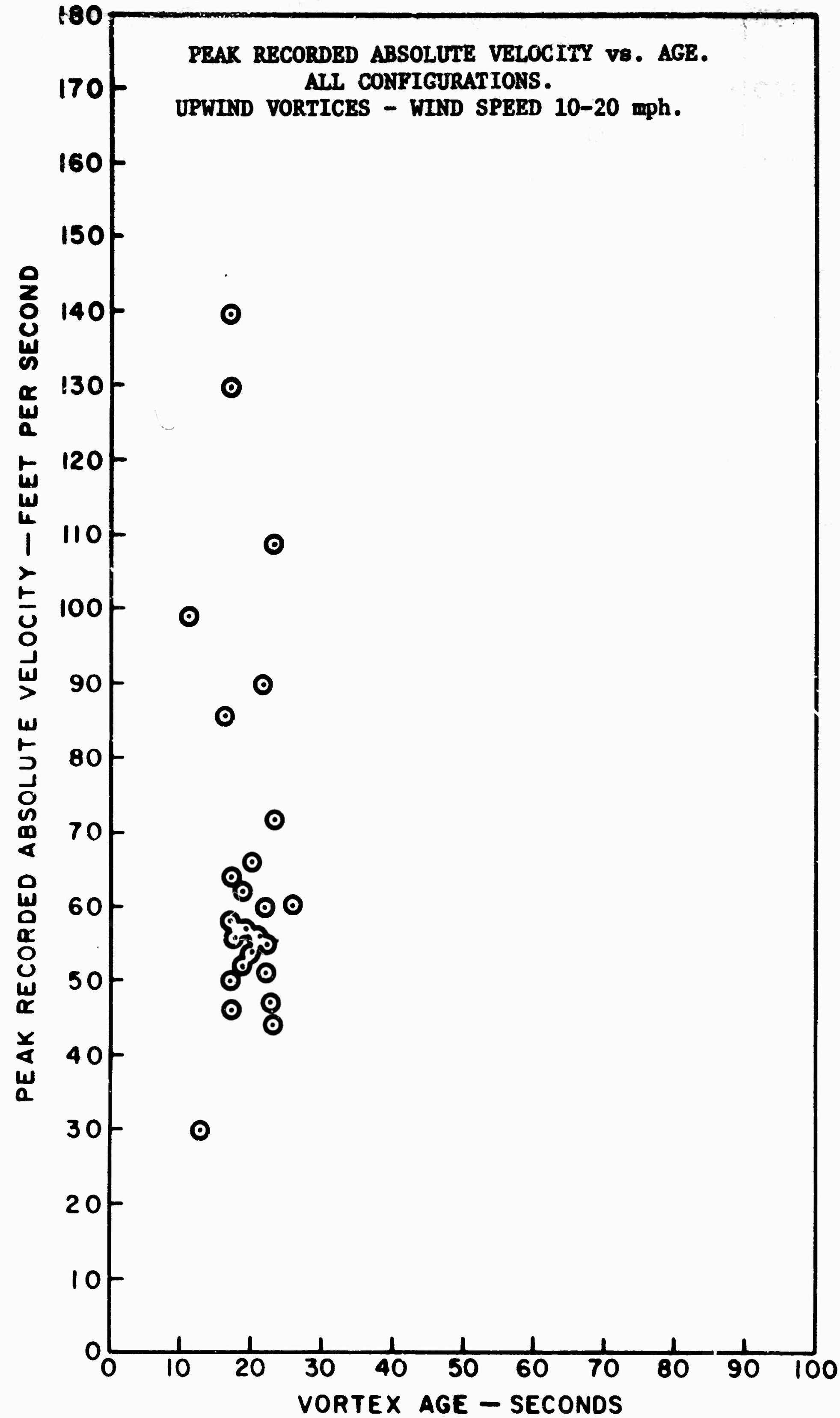
150
160
170
180


PEAK RECORDED ABSOLUTF VELOCITY vs. AGE.
ALL CONFIGURATIONS.
UPWIND VORTICES - WIND SPEED 0-5 mph.
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
0
10
20
30
40
50
60
70
80
90
100
VORTEX AGE — SECONDS



PEAK RECORDED ABSOLUTE VELOCITY vs. AGE.
ALL CONFIGURATIONS.
UPWIND VORTICES - WIND SPEED 5-10 mph.


PEAK RECORDED ABSOLUTE VELOCITY vs. AGE.
ALL CONFIGURATIONS.
UPWIND VORTICES - WIND SPEED 10-20 mph.
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
VORTEX AGE — SECONDS
0
10
20
30
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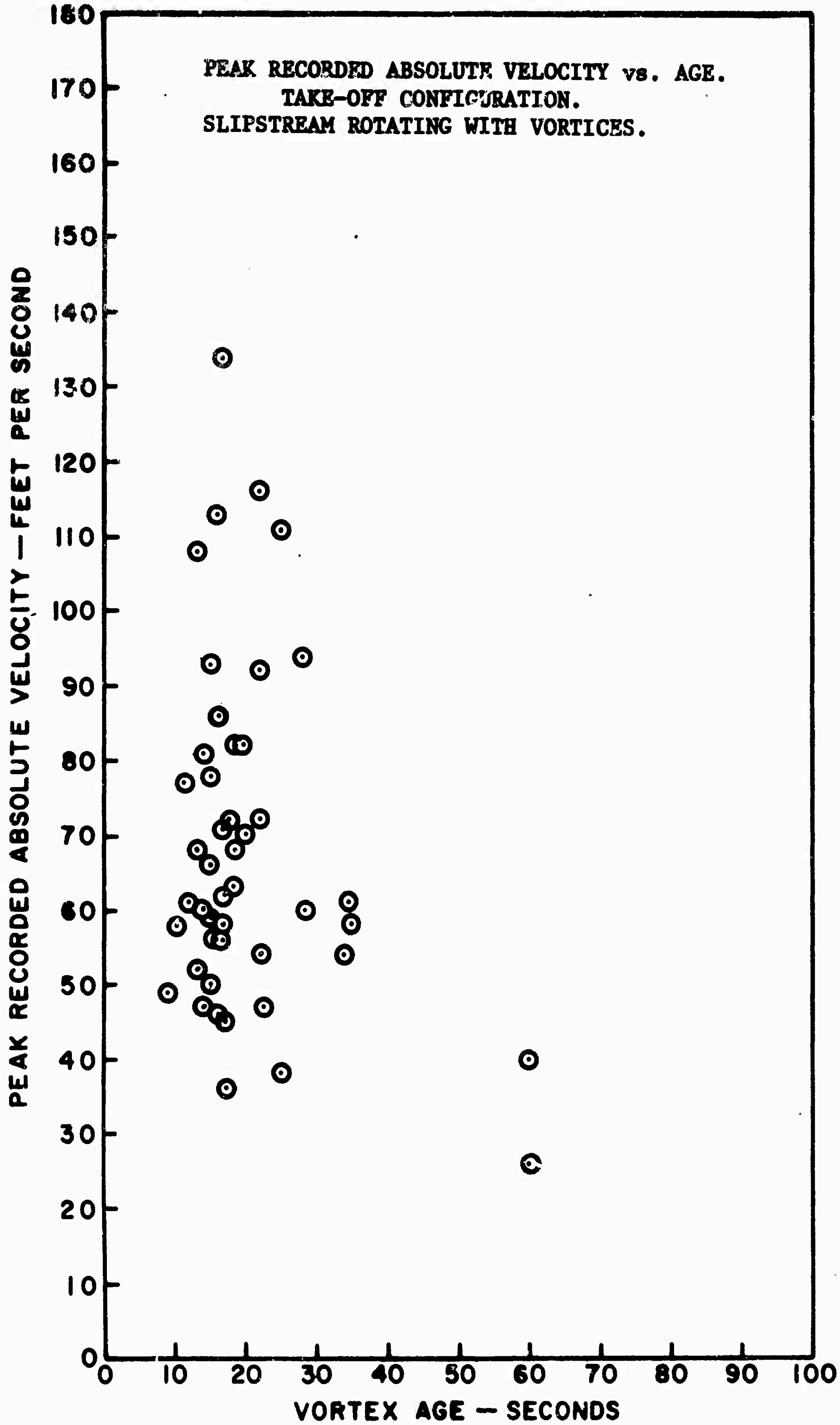
50
60
70
80
90
100
110
120
130
140
150
160
170
180


PEAK RECORDED ABSOLUTE VELOCITY vs. AGE.
TAKE-OFF CONFIGURATION.
SLIPSTREAM ROTATING WITH VORTICES.
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
VORTEX AGE — SECONDS
0
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120
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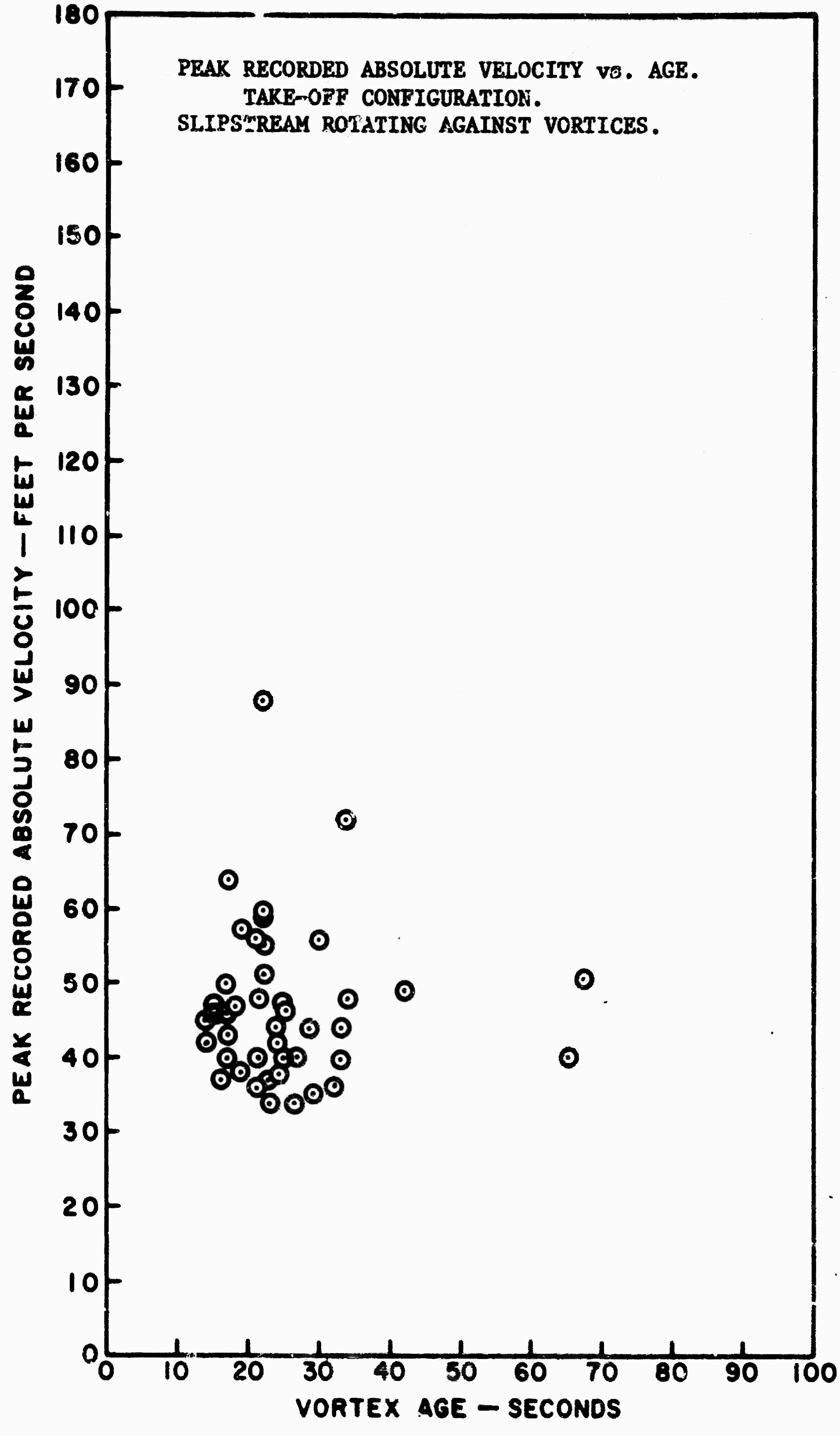
PEAK RECORDED ABSOLUTE VELOCITY vs. AGE.
TAKE-OFF CONFIGURATION.
SLIPSTREAM ROTATING AGAINST VORTICES.
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
VORTEX AGE — SECONDS
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110
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140
150
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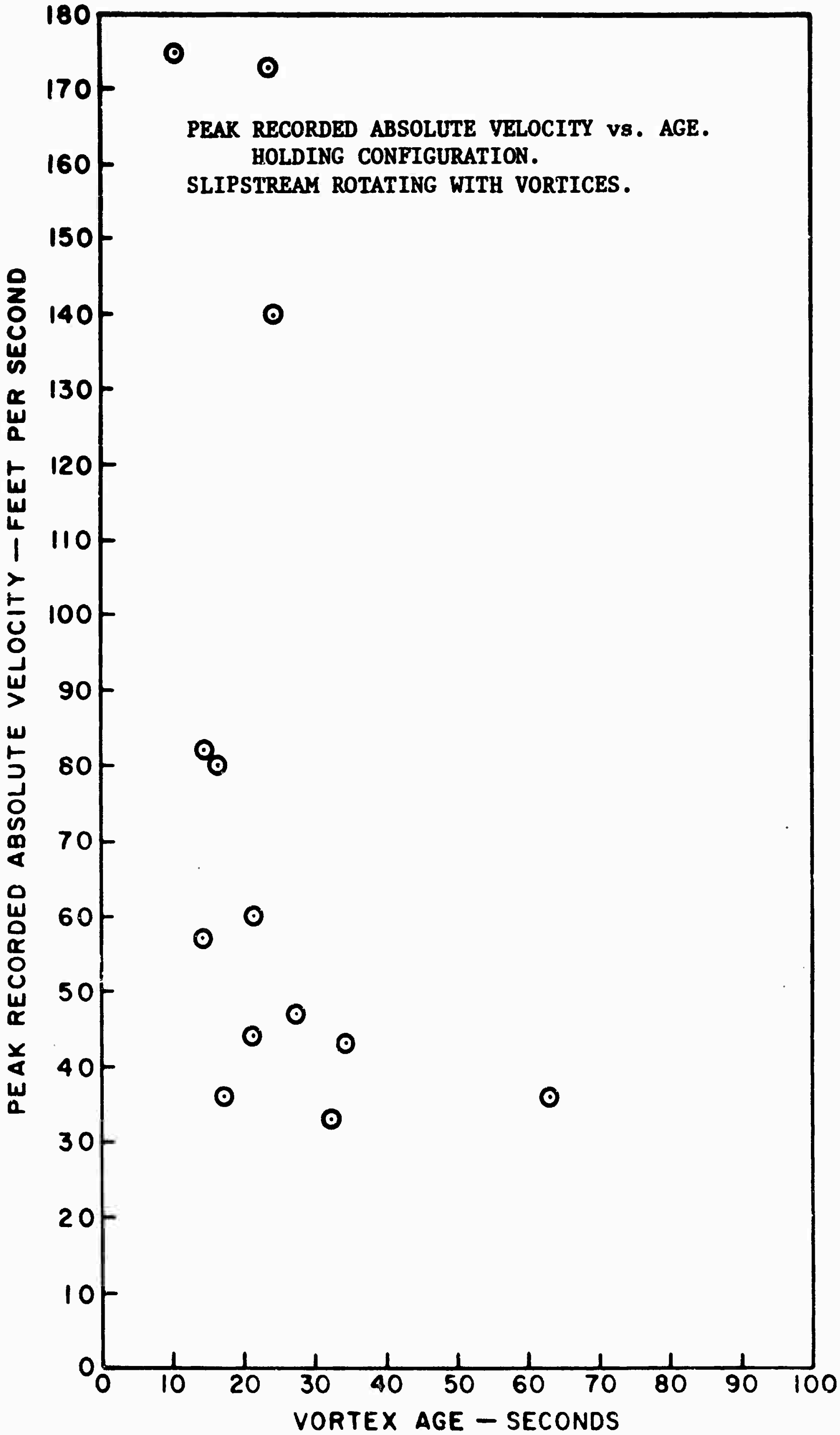
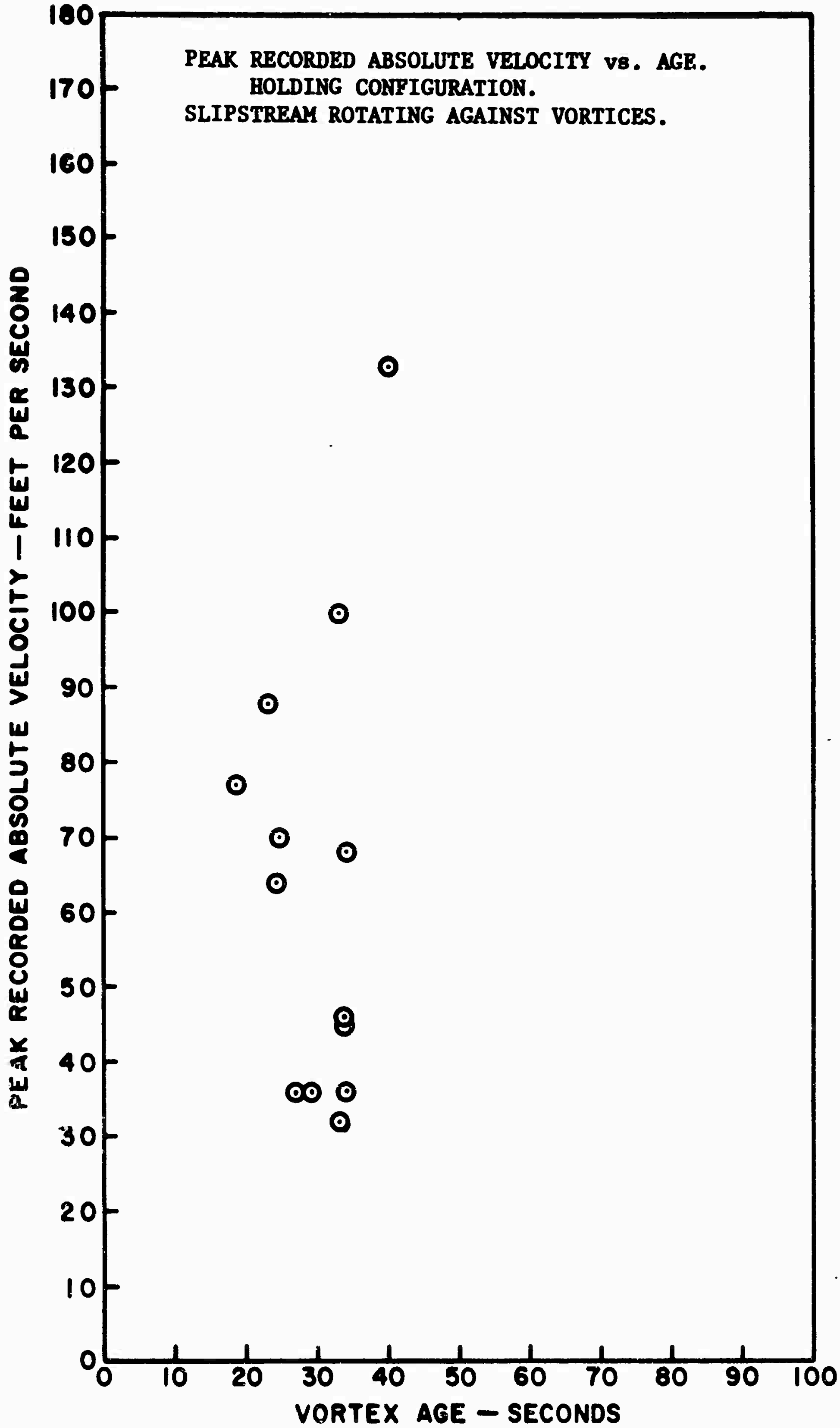
170
180


PEAK RECORDED ABSOLUTE VELOCITY vs. AGE.
HOLDING CONFIGURATION.
SLIPSTREAM ROTATING WITH VORTICES.
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
VORTEX AGE — SECONDS
0
10
20
30
40
50
60
70
80
90
100


PEAK RECORDED ABSOLUTE VELOCITY vs. AGE.
HOLDING CONFIGURATION.
SLIPSTREAM ROTATING AGAINST VORTICES.
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
0
10
20
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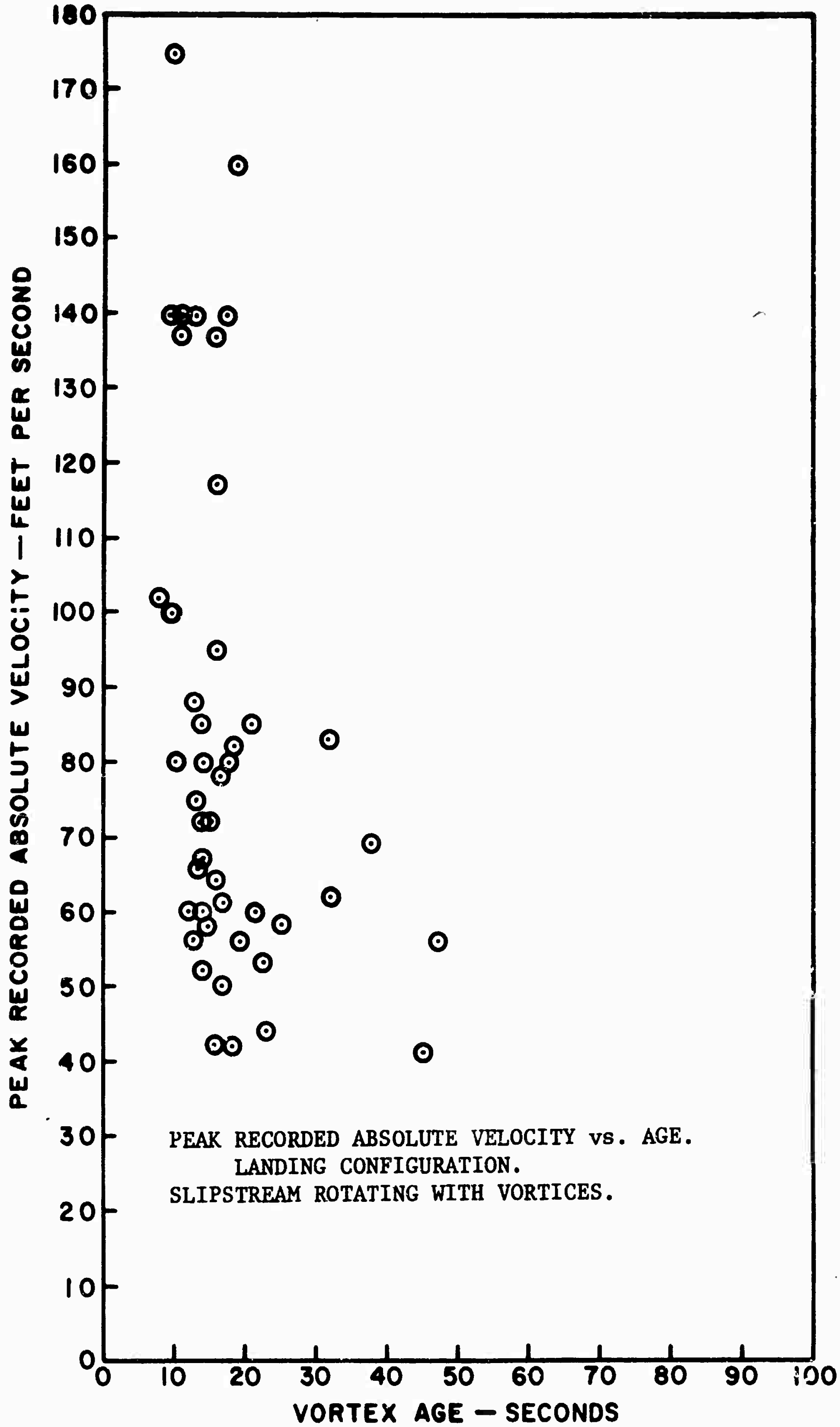
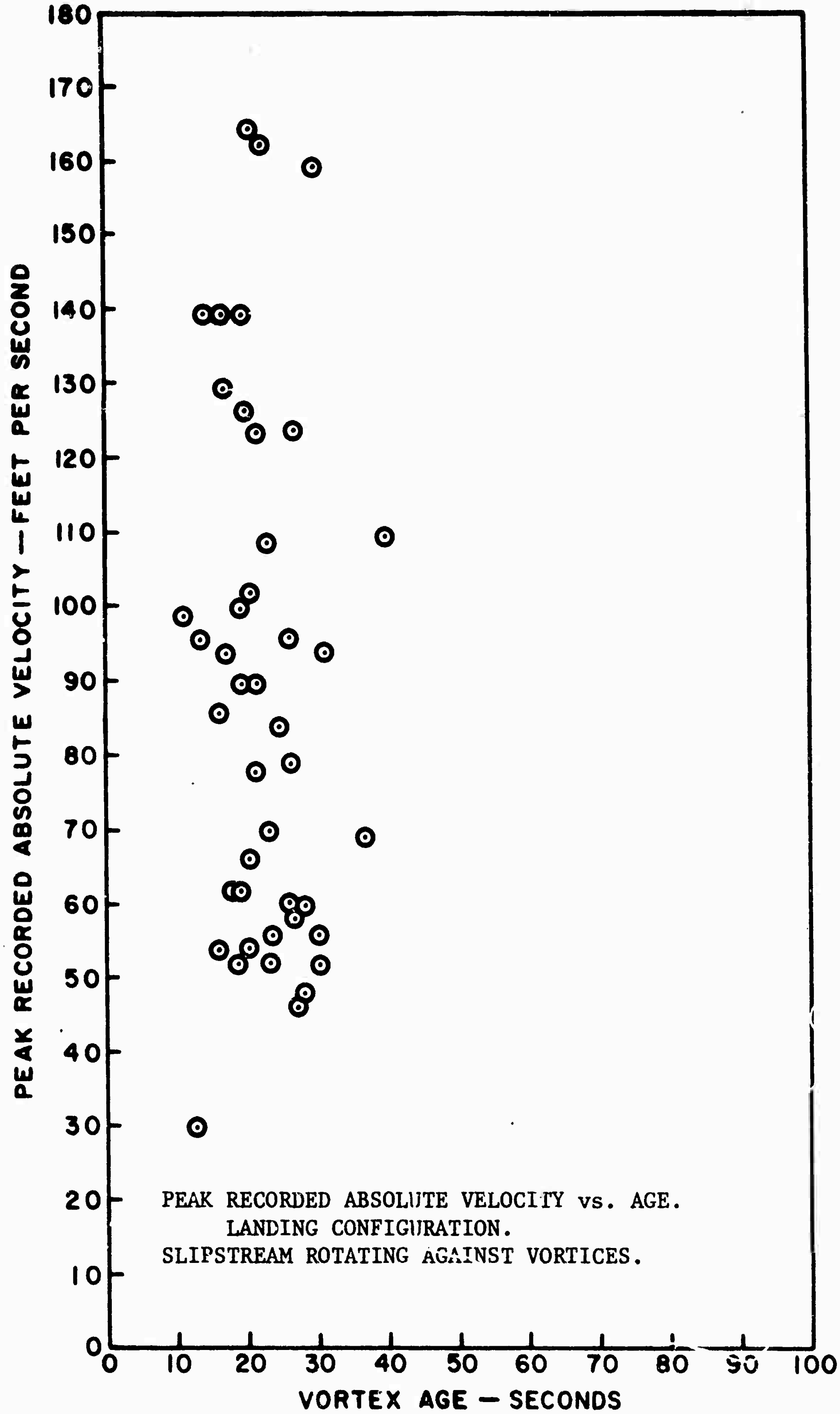
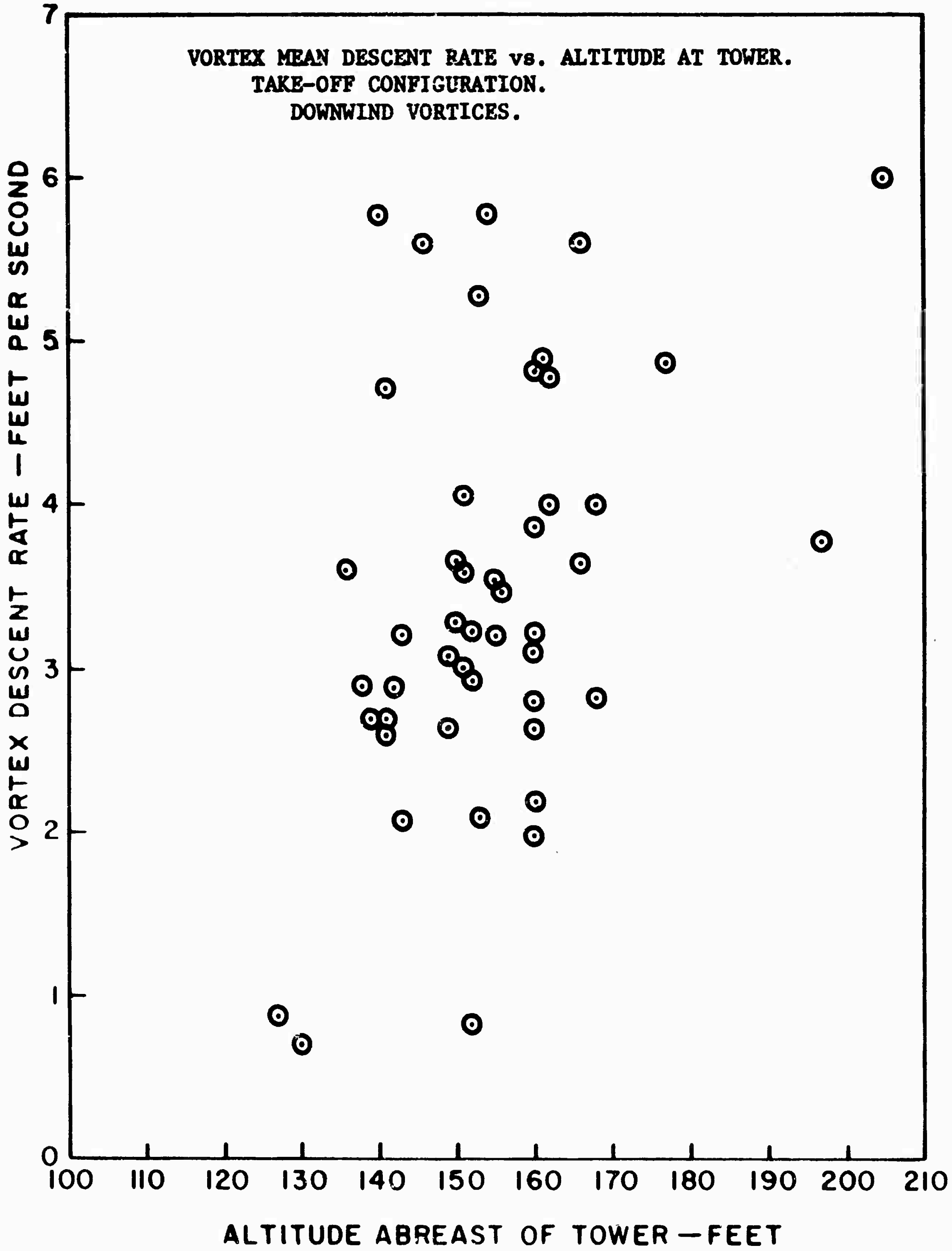
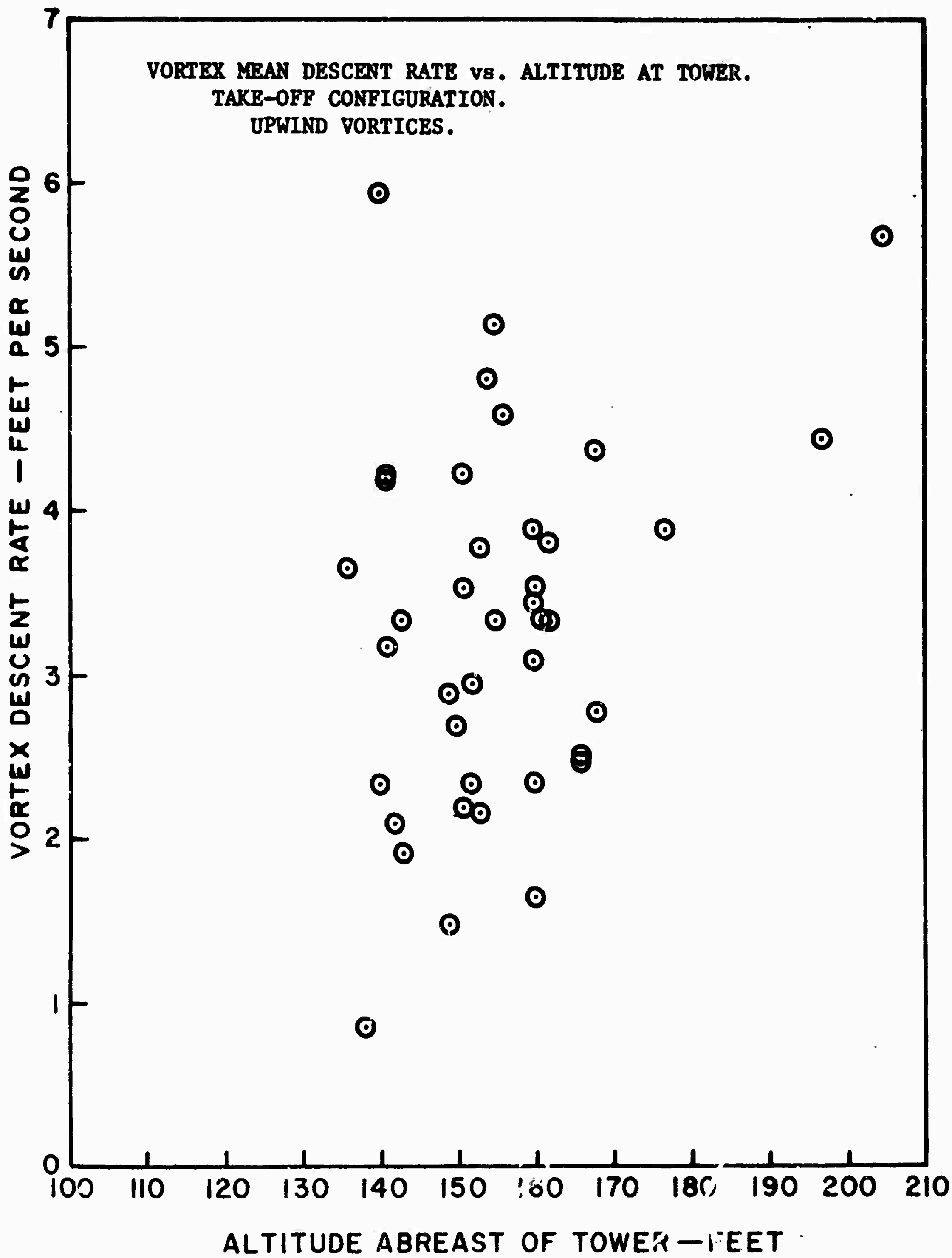
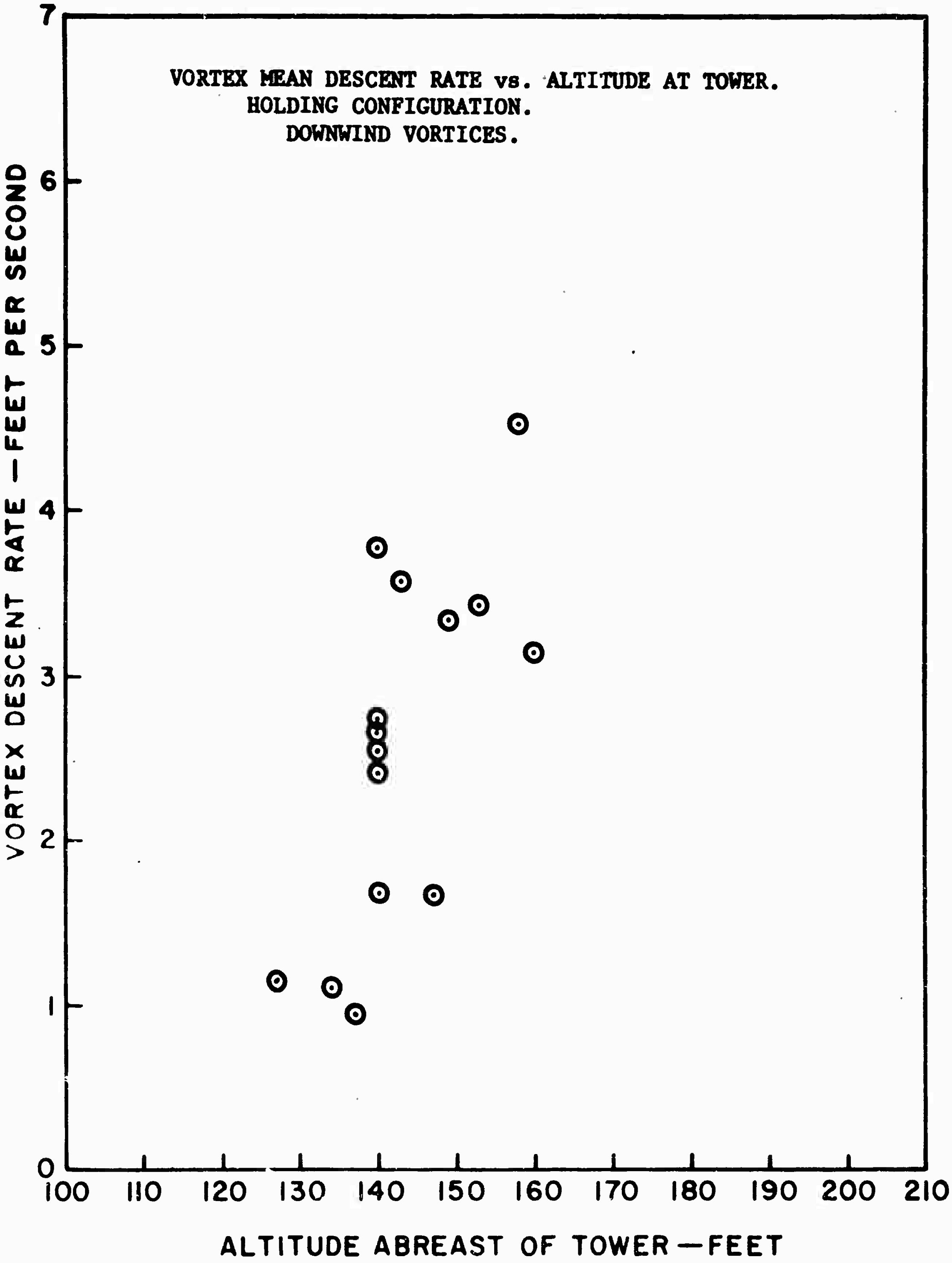
50
60
70
80
90
100
110
120
130
140
150
160
170
180
0
10
20
30
40
50
60
70
80
90
100
VORTEX AGE — SECONDS

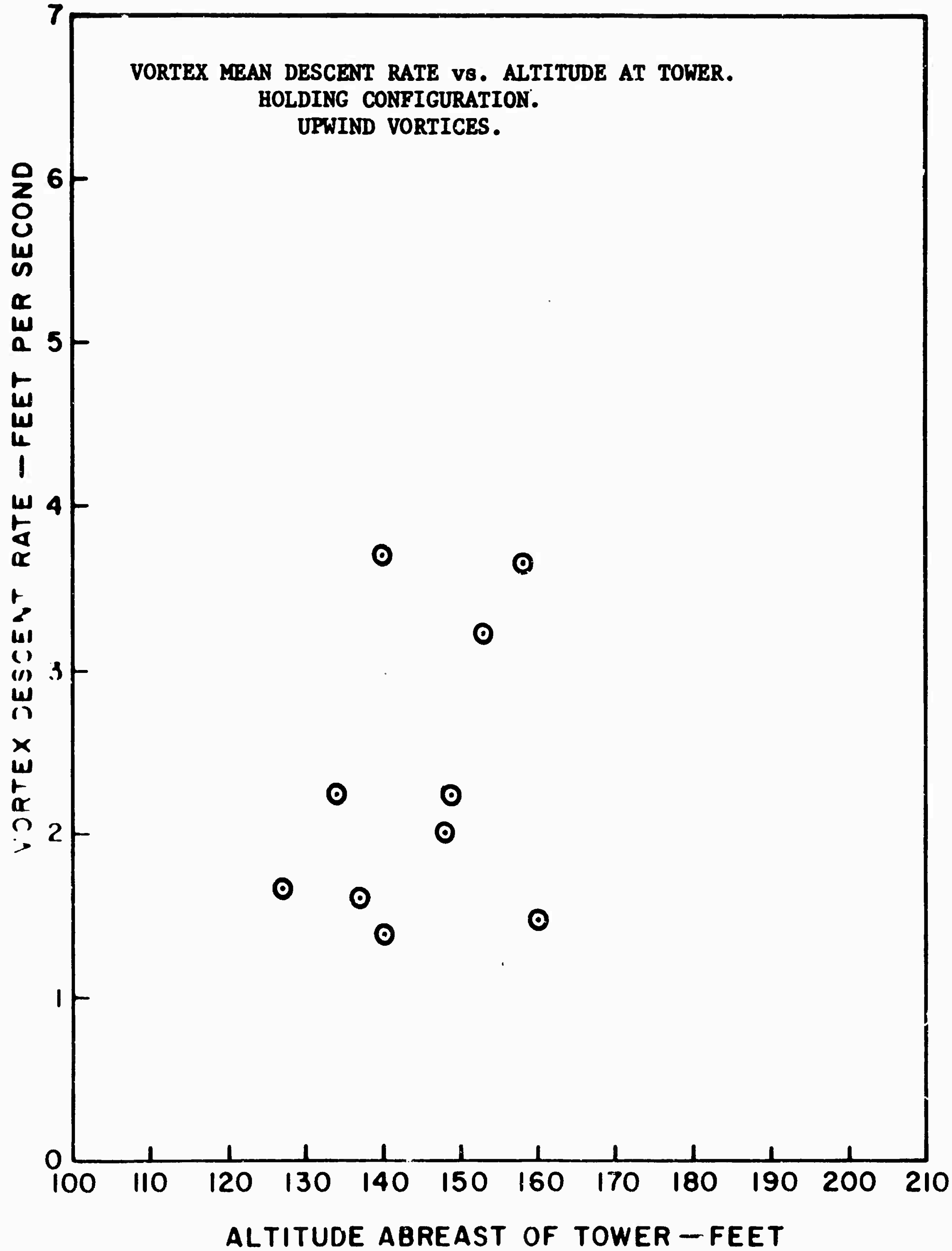

PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
VORTEX AGE — SECONDS
0
10
20
30
40
50
60
70
80
90
100
PEAK RECORDED ABSOLUTE VELOCITY vs. AGE.
LANDING CONFIGURATION.
SLIPSTREAM ROTATING WITH VORTICES.

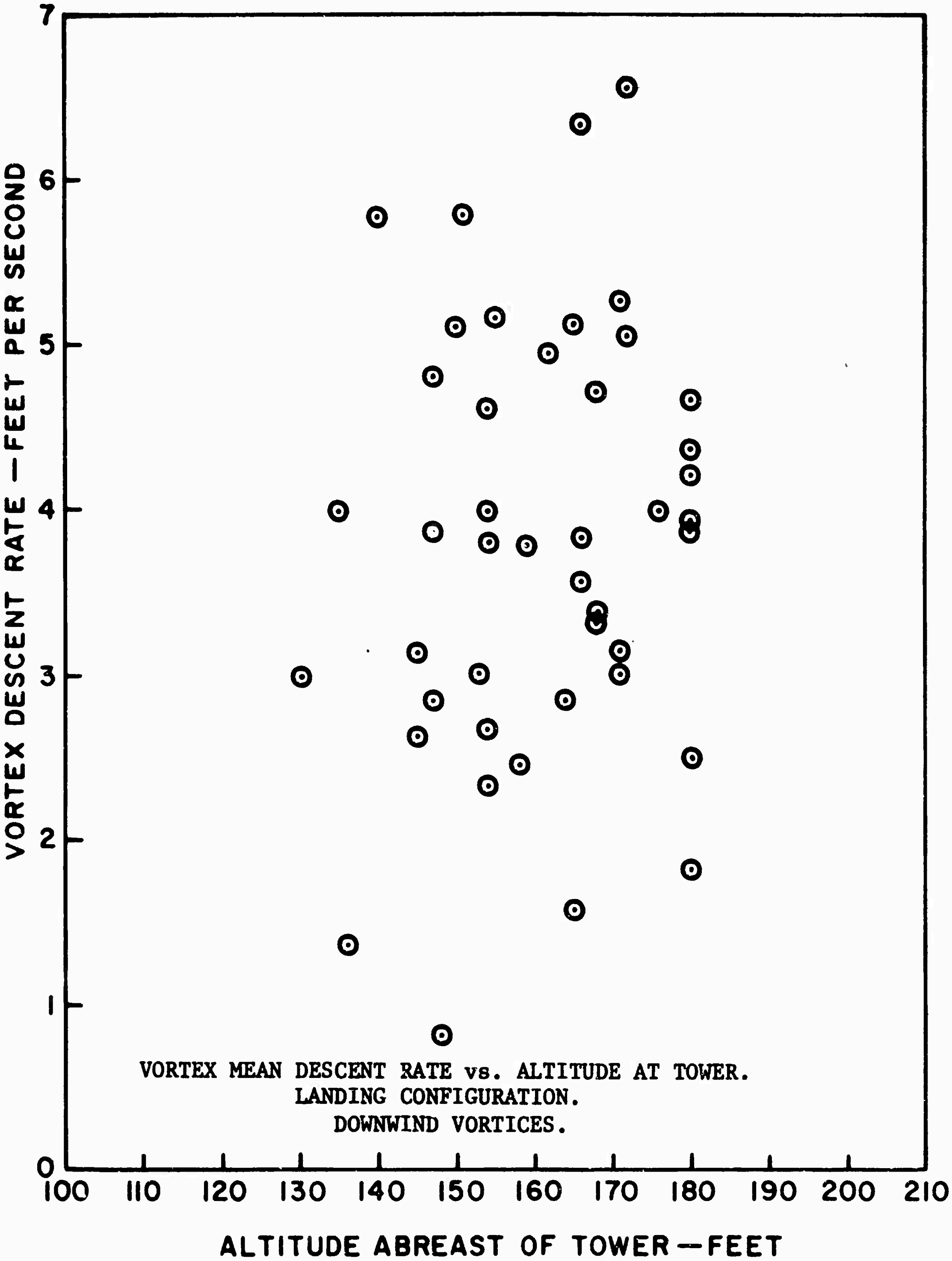

PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
VORTEX AGE — SECONDS
PEAK RECORDED ABSOLUTE VELOCITY vs. AGE.
LANDING CONFIGURATION.
SLIPSTREAM ROTATING AGAINST VORTICES.


VORTEX MEAN DESCENT RATE vs. ALTITUDE AT TOWER.
TAKE-OFF CONFIGURATION.
DOWNWIND VORTICES.
VORTEX DESCENT RATE — FEET PER SECOND
0
1
2
3
4
5
6
7
100
110
120
130
140
150
160
170
180
190
200
210
ALTITUDE ABREAST OF TOWER — FEET

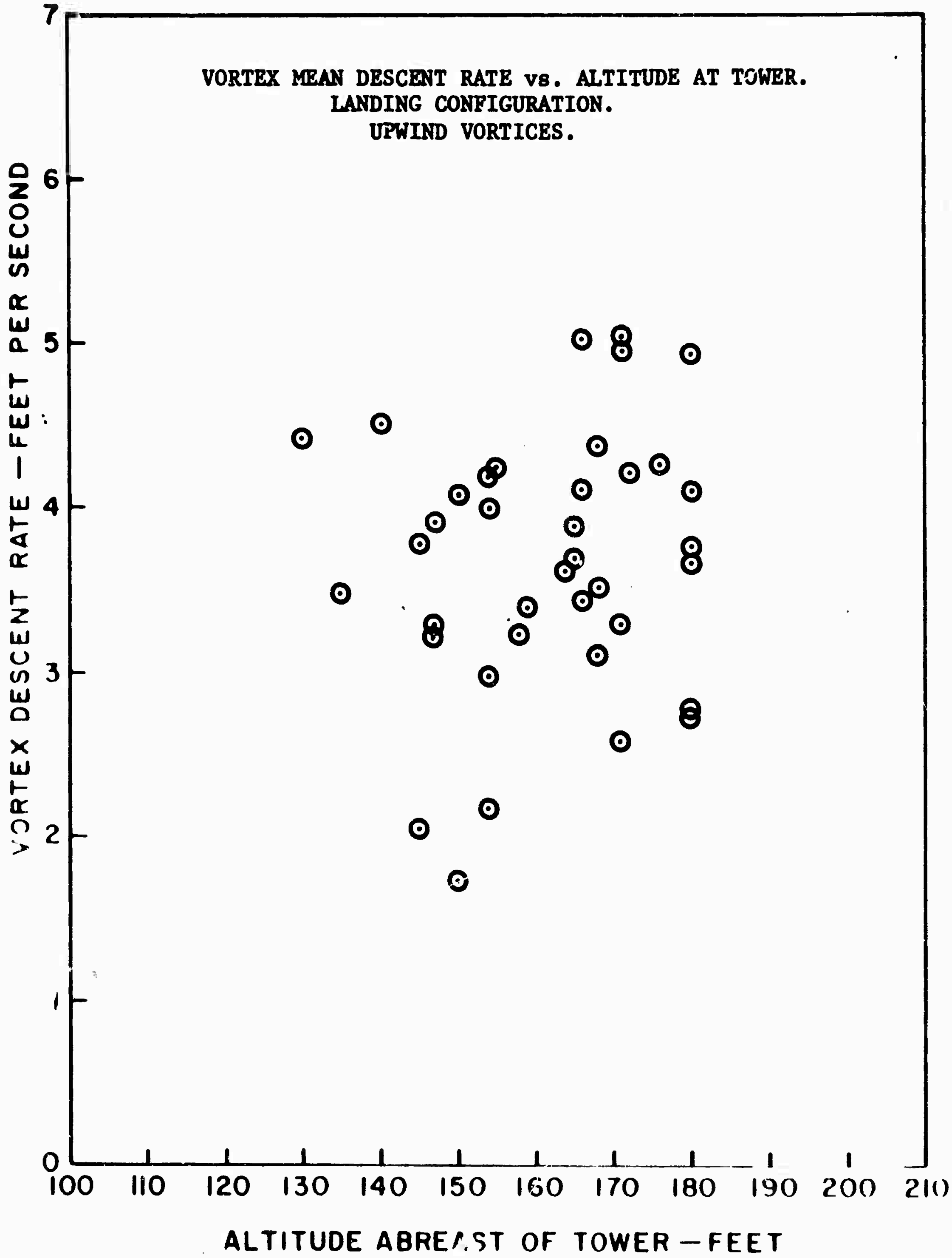

VORTEX MEAN DESCENT RATE vs. ALTITUDE AT TOWER.
TAKE-OFF CONFIGURATION.
UPWIND VORTICES.
VORTEX DESCENT RATE — FEET PER SECOND
ALTITUDE ABREAST OF TOWER — FEET
0
1
2
3
4
5
6
7
100
110
120
130
140
150
160
170
180
190
200
210


VORTEX MEAN DESCENT RATE vs. ALTITUDE AT TOWER.
HOLDING CONFIGURATION.
DOWNWIND VORTICES.
VORTEX DESCENT RATE — FEET PER SECOND
0
1
2
3
4
5
6
7
100
110
120
130
140
150
160
170
180
190
200
210
ALTITUDE ABREAST OF TOWER — FEET


VORTEX MEAN DESCENT RATE vs. ALTITUDE AT TOWER.
HOLDING CONFIGURATION.
UPWIND VORTICES.
VORTEX DESCENT RATE — FEET PER SECOND
0
1
2
3
4
5
6
7
100
110
120
130
140
150
160
170
180
190
200
210
ALTITUDE ABREAST OF TOWER — FEET



VORTEX MEAN DESCENT RATE vs. ALTITUDE AT TOWER.
LANDING CONFIGURATION.
DOWNWIND VORTICES.


VORTEX MEAN DESCENT RATE vs. ALTITUDE AT TOWER.
LANDING CONFIGURATION.
UPWIND VORTICES.
VORTEX DESCENT RATE — FEET PER SECOND
0
1
2
3
4
5
6
7
100
110
120
130
140
150
160
170
180
190
200
210
ALTITUDE ABREAST OF TOWER — FEET

APPENDIX G

SUMMARY FLIGHT TEST

DATA SHEETS

SUMMARY FLIGHT TEST DATA SHEET

DATE 9-1-71 AIRCRAFT DC-7 COMPANY FAA REGISTRATION N464

AIRCRAFT CREW Bazer/Stephens/Terry FIELD ELEVATION 76 ft. ATM TURB. LEVEL AT TEST ALT. None

TEST LOCATION NAFEC 140 ft. Test Tower.

Run Number	61	62	63	64	65	66	67	68	69	70	71	72
Time	0908	0912	0916	0920	0930	0935	0939	0943	0948	0952	0956	1000
Aircraft Position[1] (ft)	213S	214S	214S	205S	199S	204S	219S	223S	208S	208S	218S	209S
Pressure Altitude ft, Altimeter set to 29.92	-140	-120	-110	-110	-90	-100	-120	-120	-100	-100	-120	-100
Aircraft Height[2] abreast of Tower, ft.	127	130	143	149	160	151	160	147	152	153	153	158
Relative Humidity, percent	84		FALLING TO		76 AT END	OF TEST	PERIOD					76
Outside Air Temp. (°C), at Test Alt.	18				19		20					
Ambient Pressure (Inches Hg).	30.17											
Wind Direction/Level (Degrees True).	070/100	090/100	100/100	100/100	080.100	070/100	070/100	065/100	085/100	085/100	095/100	100/100
Wind Velocity/Level (MPH).	4/100	4/100	4/100	4/100	8/100	7/100	6/100	7/100	8/100	8/100	8/100	8/100
Equivalent Airspeed (Knots).	126	123	140	140	125	125	140	140	127	125	144	140
Glide Path Angle (Degrees).	0											
Aircraft Track (Degrees Magnetic).	010											
Aircraft Gross Weight (lb x 1000).	92.0	91.7	91.5	91.3	90.7	90.4	90.1	89.9	89.5	89.3	89.1	88.9
Landing Gear UP or DOWN	D	D	U	U	D	D	U	U	D	D	U	U
Aircraft Configuration[3]	TO	TO	H	H	TO	TO	H	H	TO	TO	H	H
Flap Setting (Degrees).	20	20	0	0	20	20	0	0	20	20	0	0
Wing Spoiler Setting (Degrees).		NONE INSTALLED										
Engine BMEP #1 (lb/in^2).	120	120	90	90	115	115	90	95	120	110	90	85
Engine RPM.	2500											
Fuel Flow/Engine (lb/hr).	800	800	500	500	800	700	500	550	750	600	500	500
Phototheodolite Operating (Yes/No).	YES											
Peak recorded absolute velocity fps, 1st vtx.	54	116	44	140	56	82	60	33	113	62	57	36
Peak recorded absolute velocity fps, 2nd vtx.	-	-	-	100	47	35	45	36	-	48	88	32
Vortex height on tower, ft, 1st vtx.	58	65	68	69	78	83	94	94	139	57	105	81
Vortex height on tower, ft, 2nd vtx.	-	-	-	75	74	88	110	59	-	40	79	74
Vortex Age, sec, 1st vtx.	22	22	21	24	17	19	21	32	16	27	14	17
Vortex Age, sec, 2nd vtx.	-	-	-	33	25	29	34	44	-	34	23	23
Mean Descent Rate, fps, 1st vtx.	0.9	0.7	3.6	3.3	4.8	3.6	3.1	1.7	0.8	2.1	3.4	4.5
Mean Descent Rate, fps, 2nd vtx.	-	-	-	2.2	3.4	2.2	1.5	2.0	-	2.2	3.2	3.7
Mean Lateral Velocity, fps, 1st vtx.	7.6	7.6	8.0	6.6	9.0	8.3	8.2	5.5	10.1	6.0	12.3	9.6
Mean Lateral Velocity, fps, 2nd vtx.	-	-	-	7.6	9.8	8.6	7.8	6.1	-	7.5	11.5	11.1
Crosswind Velocity component, fps:	5.5	5.9	5.9	5.9	11.6	9.7	7.6	8.4	11.7	11.7	11.7	11.7
Median Circulation ft^2/sec.	2390	2430	1940	1930	2370	2365	1910	1900	2310	2340	1830	1880

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SUMMARY FLIGHT TEST DATA SHEET

DATE 9-2-71 AIRCRAFT DC-7 COMPANY FAA REGISTRATION N464

AIRCRAFT CREW Bazer/Stephens/Terry FIELD ELEVATION 76 ft ATM TURB. LEVEL AT TEST ALT. NONE

TEST LOCATION NAFEC 140 ft Test Tower

Run Number	73	74	75	76	77	78	79	80	81	82	83	84
Time	0646	0651	0656	0702	0707	0712	0717	0724	0729	0734	0739	0744
Aircraft Position[1] (ft)	177S	201S	154S	191S	184S	185S	196S	178S	206S	204S	201S	195S
Pressure Altitude ft, Altimeter set to 29.92	-170	-160	-180	-170	-170	-185	-170	-150	-175	-165	-170	-200
Aircraft Height[2] abreast of Tower, ft	143	154	134	138	136	127	141	158	137	149	145	140
Relative Humidity, percent	98											92
Outside Air Temp. (°C), at Test Alt.	15											
Ambient Pressure (Inches Hg).	30.25											
Wind Direction/Level (Degrees True).	063/100	090/100	095/100	095/100	095/100	095/100	095/100	100/100	095/100	090/100	100/100	100/100
Wind Velocity/Level (MPH).	3/100	6/100	5/100	5/100	5/100	5/100	7/100	6/100	5/100	3/100	4/100	2/100
Equivalent Airspeed (Knots).	125	120	140	125	122	144	122	120	140	128	124	140
Glide Path Angle (Degrees).	0											
Aircraft Track (Degrees Magnetic).	040											
Aircraft Gross Weight (lb x 1000).	91.0	90.7	90.4	90.2	89.9	89.7	89.5	89.1	88.9	88.7	88.4	88.2
Landing Gear UP or DOWN	D	D	U	D	D	U	D	D	U	D	D	U
Aircraft Configuration[3]	TO	L	H	TO	L	H	TO	L	H	TO	L	H
Flap Setting (Degrees).	20	50	0	20	50	0	20	50	0	20	50	0
Wing Spoiler Setting (Degrees).												
Engine BMEP #1 (lb/in^2).	120	170	90	120	170	90	110	150	80	110	160	90
Engine RPM.	2500	2600	2500	2500	2600	2500	2500	2600	2500	2500	2600	2500
Fuel Flow/Engine (lb/hr).	700	1300	500	500	1300	500	650	1000	450	500	1025	500
Phototheodolite Operating (Yes/No).	YES											
Peak recorded absolute velocity fps, 1st vtx.	70	175	175	63	-	82	61	137	80	134	160	173
Peak recorded absolute velocity fps, 2nd vtx.	49	160	70	51	-	68	46	165	133	40	110	-
Vortex height on tower, ft, 1st vtx.	79	93	123	86	-	111	110	131	122	97	95	79
Vortex height on tower, ft, 2nd vtx.	63	49	79	82	-	71	62	90	73	54	63	-
Vortex Age, sec, 1st vtx.	20	16	10	18	-	14	12	11	16	17	12	23
Vortex Age, sec, 2nd vtx.	42	30	24.5	67	-	34	25	21	40	65	40	-
Mean Descent Rate, fps, 1st vtx.	3.2	3.8	1.1	2.9	-	1.1	2.6	2.5	0.9	3.1	2.6	2.7
Mean Descent Rate, fps, 2nd vtx.	1.9	2.2	2.2	0.8	-	1.7	3.2	3.2	1.6	1.5	2.1	-
Mean Lateral Velocity, fps, 1st vtx.	6.6	9.7	10.8	8.1	-	9.9	12.5	12.0	10.0	9.3	8.2	6.5
Mean Lateral Velocity, fps, 2nd vtx.	5.3	8.2	8.2	3.5	-	6.8	9.7	10.7	6.3	6.8	6.2	-
Crosswind Velocity component, fps:	2.4	7.6	6.6	6.7	6.6	6.6	9.3	8.3	6.6	3.8	5.5	2.8
Median Circulation ft^2/sec.	2380	2560	1910	2360	-	1840	2380	2520	1880	2280	2440	1860

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SUMMARY FLIGHT TEST DATA SHEET

DATE 9-16-71 AIRCRAFT DC-7 COMPANY FAA REGISTRATION N464

AIRCRAFT CREW Stephens/Decker/Auer FIELD ELEVATION 76 ft. ATM TURB. LEVEL AT TEST ALT. NONE

TEST LOCATION NAFEC 140 ft. Test Tower.

Run Number	85	86	87	88	89	90	91	92	93	94	95	96
Time	0917	0921	0926	0931	0936	0940	0944	0955	1000	1004	1008	1012
Aircraft Position[1] (ft)	322P	304P	296P	276P	297P	343P	308P	314P	335P	323P	300P	300P
Pressure Altitude ft, Altimeter set to 29.92	75	115	30	75	110	40	75	110	60	60	80	50
Aircraft Height[2] abreast of Tower, ft.	160	180	140	160	180	140	160	180	140	160	180	140
Relative Humidity, percent	84				79					78	73	74
Outside Air Temp. (°C), at Test Alt.	24					25						
Ambient Pressure (Inches Hg).	29.99			30.00								
Wind Direction/Level (Degrees True).	260/100	280/100	270/100	250/100	250/100	260/100	260/100	255/100	245/100	275/100	280/100	285/100
Wind Velocity/Level (MPH).	[illegible]/100	6/100	6/100	6/100	5/100	5/100	5/100	5/100	6/100	2/100	5/100	5/100
Equivalent Airspeed (Knots).	125	122	145	120	126	150	123	123	150	134	122	160
Glide Path Angle (Degrees).	0											
Aircraft Track (Degrees Magnetic).	000											
Aircraft Gross Weight (lb x 1000).	94.2	93.8	93.4	93.0	92.6	92.2	91.8	91.4	91.0	90.6	90.2	89.8
Landing Gear UP or DOWN	D	D	U	D	D	U	D	D	U	D	D	U
Aircraft Configuration[3]	TO	L	H	TO	L	H	TO	L	H	TO	L	H
Flap Setting (Degrees).	20	40	0	20	40	0	20	40	0	20	40	0
Wing Spoiler Setting (Degrees).			NONE INSTALLED									
Engine BMEP #1 (lb/in²).	135	175	95	135	152	85	155	170	90	110	180	90
Engine RPM.	2500	2500	2300	2500	2500	2300	2500	2500	2300	2500	2650	2300
Fuel Flow/Engine (lb/hr).	900	1300	450	800	1100	400	1000	1300	450	650	1500	900
Phototheodolite Operating (Yes/No).	NO											
Peak recorded absolute velocity fps, 1st vtx.	38	140	77	88	163	64	44	48	46	72	60	36
Peak recorded absolute velocity fps, 2nd vtx.	58	58	47	60	62	43	26	41	36	40	-	-
Vortex height on tower, ft, 1st vtx.	113	98	70	75	75	100	54	110	50	87	58	66
Vortex height on tower, ft, 2nd vtx.	78	75	40	49	39	55	-	56	55	62	-	-
Vortex Age, sec, 1st vtx.	24	19.5	18.5	22	22.5	24	33	28	33.5	33.5	28	27
Vortex Age, sec, 2nd vtx.	35	25.5	27	28.5	32	34	60	44.5	62.5	60	-	-
Mean Descent Rate, fps, 1st vtx.	2.0	4.2	3.8	3.9	4.[illegible]	3.7	3.2	2.5	2.5	2.2	4.4	2.7
Mean Descent Rate, fps, 2nd vtx.	2.3	4.1	3.7	4.0	3.8	2.5	-	2.8	1.4	1.6	-	-
Mean Lateral Velocity, fps, 1st vtx.	11.5	13.2	13.5	10.5	11.2	11.0	7.9	9.6	8.6	8.3	9.1	9.4
Mean Lateral Velocity, fps, 2nd vtx.	10.5	13.7	12.7	11.3	10.7	11.4	5.9	8.1	6.1	6.2	-	-
Crosswind Velocity component, fps:	8.8	8.3	8.7	8.7	7.2	7.3	7.3	7.3	8.5	2.8	6.9	6.6
Median Circulation ft²/sec.	2450	2600	1900	2510	2510	1820	2430	2520	1790	2240	2500	1660

[1]Aircraft C/L Lateral Offset (ft), from tower. P = To port of tower. S = To starboard of tower.

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SUMMARY FLIGHT TEST DATA SHEET

DATE 9-16-71 AIRCRAFT DC-7 COMPANY FAA REGISTRATION N464

AIRCRAFT CREW Stephens/Decker/Auer FIELD ELEVATION 76 ft. ATM TURB. LEVEL AT TEST ALT. NONE

TEST LOCATION NAFEC 140 ft. Test Tower

Run Number	97	98	99	100	101	102	103	104	105			
Time	1016	1021	1026	1031	1035	1040	1044	1048	1052			
Aircraft Position[1] (ft)	297P	300P	300P	300P	300P	300P	300P	252P	240P			
Pressure Altitude ft, Altimeter set to 29.92	75	90	40	70	110	30	50	90	30			
Aircraft Height[2] abreast of Tower, ft.	160	180	140	160	180	140	160	180	140			
Relative Humidity, percent	72	72	71	69	70	70	70	69	70			
Outside Air Temp. (°C), at Test Alt.	25						→	26	→			
Ambient Pressure (Inches Hg).	30.00	→	30.01						→			
Wind Direction/Level (Degrees True).	275/100	280/100	280/100	280/100	290/100	285/100	240/100	210/100	235/100			
Wind Velocity/Level (MPH).	4/100	4/100	4/100	4/100	3/100	3/100	3/100	1/100	3/100			
Equivalent Airspeed (Knots).	128	120	152	130	124	150	130	126	150			
Glide Path Angle (Degrees).	0								→			
Aircraft Track (Degrees Magnetic).	000								→			
Aircraft Gross Weight (lb x 1000).	89.4	89.0	88.6	88.2	87.8	87.4	87.0	86.6	86.2			
Landing Gear UP or DOWN	D	D	U	D	D	U	D	D	U			
Aircraft Configuration[3]	TO	L	H	TO	L	H	TO	L	H			
Flap Setting (Degrees).	20	40	0	20	40	0	20	40	0			
Wing Spoiler Setting (Degrees).			NONE INSTALLED						→			
Engine BMEP #1 (lb/in^2).	130	120	105	130	170	90	100	160	90			
Engine RPM.	2500	2500	2300	2500	2500	2300	2500	2500	2300			
Fuel Flow/Engine (lb/hr).	750	1500	540	750	1300	440	600	1100	450			
Phototheodolite Operating (Yes/No).	NO								→			
Peak recorded absolute velocity fps, 1st vtx.	34	79	-	34	-	-	40	94	36			
Peak recorded absolute velocity fps, 2nd vtx.	54	69	-	61	56	-	-	-	-			
Vortex height on tower, ft, 1st vtx.	100	133	-	86	-	-	58	58	70			
Vortex height on tower, ft, 2nd vtx.	55	40	-	38	50	-	-	-	-			
Vortex Age, sec, 1st vtx.	23	26	-	26.5	-	-	33	31	29			
Vortex Age, sec, 2nd vtx.	34	38	-	34.5	47.5	-	-	-	-			
Mean Descent Rate, fps, 1st vtx.	2.6	1.8	-	2.8	-	-	3.1	3.9	-2.4			
Mean Descent Rate, fps, 2nd vtx.	3.1	3.7	-	3.5	2.7	-	-	-	-			
Mean Lateral Velocity, fps, 1st vtx.	10.9	9.8	-	9.6	-	-	7.7	6.6	6.7			
Mean Lateral Velocity, fps, 2nd vtx.	9.9	9.1	-	10.0	7.3	-	-	-	-			
Crosswind Velocity component, fps:	5.7	5.5	-	5.5	3.8	-	4.1	0.9	4.0			
Median Circulation ft^2/sec.	2270	2510	-	2240	2420	-	2210	2370	1690			

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SUMMARY FLIGHT TEST DATA SHEET

DATE 9-17-71 AIRCRAFT DC-7 COMPANY FAA REGISTRATION N464

AIRCRAFT CREW Stephens/Osterhout/Terry FIELD ELEVATION 76 ft. ATM TURB. LEVEL AT TEST ALT. NONE

TEST LOCATION NAFEC 140 ft. Test Tower

Run Number	106	107	108	109	110	111	112	113	114	115	116	117
Time	1052	1057	1101	[illegible]6	1112	1117	1124	1130	1136	1141	1147	1153
Aircraft Position[1] (ft)	300S	300S	300S	[illegible]	325S	325S	325S	325S	325S	325S	325S	325S
Pressure Altitude ft, Altimeter set to 29.92	20	15	10	[illegible]0	40	-20	0	20	-20	0	40	-10
Aircraft Height[2] abreast of Tower, ft.	150	140	140	145	150	100	120	140	100	120	140	100
Relative Humidity, percent	77	→	→	80	80	78	80	76	→	→	→	→
Outside Air Temp. (°C), at Test Alt.	25	→	→	→	→	→	→	→	→	→	→	→
Ambient Pressure (Inches Hg).	30.05	→	→	→	→	→	30.04	→	→	→	→	→
Wind Direction/Level (Degrees True).	170/140	175/140	175/	165/	170/	170/	175/	175/	183/	173/	160/	153/
Wind Velocity/Level (MPH).	8/140	10/	10/	10/	10/	9/	12/	11/	10/	10/	9/	8/
Equivalent Airspeed (Knots).	130	130	140	130	120	145	125	120	145	125	125	140
Glide Path Angle (Degrees).	0	→	→	→	→	→	→	→	→	→	→	→
Aircraft Track (Degrees Magnetic).												
Aircraft Gross Weight (lb x 1000).	91.0	89.6	89.2	88.8	88.4	88.0	87.6	87.2	86.8	86.4	86.0	85.6
Landing Gear UP or DOWN	D	D	U	D	D	U	D	D	U	D	D	U
Aircraft Configuration[3]	TO	L	H	TO	L	H	TO	L	H	TO	L	H
Flap Setting (Degrees).	20	40	0	20	40	0	20	40	0	20	40	0
Wing Spoiler Setting (Degrees).	NONE INSTALLED	→	→	→	→	→	→	→	→	→	→	→
Engine BMEP #1 (lb/in^2).	110	170	100	100	175	90	110	160	100	105	160	90
Engine RPM.	2500	2600	2400	2500	2600	2400	2500	2600	2400	2500	2600	2400
Fuel Flow/Engine (lb/hr).	675	1000	450	550	1150	450	600	1000	500	600	1000	450
Phototheodolite Operating (Yes/No).	YES	→	→	→	→	→	→	→	→	→	→	→
Peak recorded absolute velocity fps, 1st vtx.	88	272	35	46	82	120	98	56	83	128	175	43
Peak recorded absolute velocity fps, 2nd vtx.	34	50	34	48	49	63	60	134	74	48	120	46
Vortex height on tower, ft, 1st vtx.	105	55	-	111	105	56	57	89	91	55	89	86
Vortex height on tower, ft, 2nd vtx.	111	55	-	78	75	29	55	65	54	42	70	58
Vortex Age, sec, 1st vtx.	10.5	15	-	11	15	19	12.5	11	14	14	14	19
Vortex Age, sec, 2nd vtx.	15.5	21.5	-	15	20	36	18	16.5	21	23	19	26
Mean Descent Rate, fps, 1st vtx.	4.3	5.7	-	3.1	3.0	2.3	5.0	4.6	.6	4.6	3.6	.7
Mean Descent Rate, fps, 2nd vtx.	2.5	4.0	-	4.5	3.8	2.0	3.6	4.5	2.2	3.4	3.7	1.6
Mean Lateral Velocity, fps, 1st vtx.	24.2	16.9	-	23.1	18.6	14.7	22.3	25.4	19.9	19.9	19.9	14.7
Mean Lateral Velocity, fps, 2nd vtx.	22.3	10.0	-	23.1	18.6	10.3	20.6	22.5	17.7	16.1	19.5	14.3
Crosswind Velocity component, fps:			-									
Median Circulation ft^2/sec.	2300	2380	-	2250	2500	1800	2300	2470	1770	2270	2370	1810

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SUMMARY FLIGHT TEST DATA SHEET

DATE 9-17-71 AIRCRAFT DC-7 COMPANY FAA REGISTRATION N464

AIRCRAFT CREW Stephens/Osterhout/Terry FIELD ELEVATION 76 ft. ATM TURB. LEVEL AT TEST ALT. NONE

TEST LOCATION NAFEC 140 ft. Test Tower

Run Number	118	119	120									
Time	1157	1201	1205									
Aircraft Position[1] (ft)	325S	325S	325S									
Pressure Altitude ft, Altimeter set to 29.92	40	40	20									
Aircraft Height[2] abreast of Tower, ft.	140	140	120									
Relative Humidity, percent	76	→	73									
Outside Air Temp. (°C), at Test Alt.	25	→	→									
Ambient Pressure (Inches Hg).	30.04	→	→									
Wind Direction/Level (Degrees True).	150/	170/	160/									
Wind Velocity/Level (MPH).	9/	10/	8/									
Equivalent Airspeed (Knots).	125	120	120									
Glide Path Angle (Degrees).	0	→	→									
Aircraft Track (Degrees Magnetic).												
Aircraft Gross Weight (lb x 1000).	85.2	84.8	84.2									
Landing Gear UP or DOWN	D	D	D									
Aircraft Configuration[3]	L	L	L									
Flap Setting (Degrees).	40	40	40									
Wing Spoiler Setting (Degrees).		NONE INSTALLED										
Engine BMEP #1 (lb/in²).	160	160	160									
Engine RPM.	2600	2600	2600									
Fuel Flow/Engine (lb/hr).	1000	1000	1000									
Phototheodolite Operating (Yes/No).	YES	→	→									
Peak recorded absolute velocity fps, 1st vtx.	96	97	78									
Peak recorded absolute velocity fps, 2nd vtx.	60	136	73									
Vortex height on tower, ft, 1st vtx.	133	105	78									
Vortex height on tower, ft, 2nd vtx.	73	42	42									
Vortex Age, sec, 1st vtx.	15	11.5	16									
Vortex Age, sec, 2nd vtx.	22.5	19.5	25.5									
Mean Descent Rate, fps, 1st vtx.	.5	3.0	2.6									
Mean Descent Rate, fps, 2nd vtx.	3.0	5.0	3.1									
Mean Lateral Velocity, fps, 1st vtx.	18.6	24.3	17.4									
Mean Lateral Velocity, fps, 2nd vtx.	16.5	19.0	14.5									
Crosswind Velocity component, fps:												
Median Circulation ft²/sec.	2350	2410	2400									

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SUMMARY FLIGHT TEST DATA SHEET

DATE 9-22-71 AIRCRAFT DC-7 COMPANY FAA REGISTRATION N464

AIRCRAFT CREW Stephens/White/Auer FIELD ELEVATION 76 ft. ATM TURB. LEVEL AT TEST ALT. LIGHT

TEST LOCATION NAFEC 140 ft. Test Tower

Run Number	121	122	123	124	125	126	127	128	129	130	131	132
Time	0919	0923	0929	0934	0938	0943	0946	0951	0955	0959	1003	1007
Aircraft Position[1] (ft)	295S	278S	297S	319S	302S	288S	296S	310S	311S	300S	283S	291S
Pressure Altitude ft, Altimeter set to 29.92	170	130	140	130	130	140	130	140	140	140	140	140
Aircraft Height[2] abreast of Tower, ft.	147	176	165	178	173	170	176	171	165	150	162	153
Relative Humidity, percent	78				76	74	74	72	72	72	70	70
Outside Air Temp. (°C), at Test Alt.	15							16				
Ambient Pressure (Inches Hg).	30.25											
Wind Direction/Level (Degrees True).	025/100	020/100	025/100	032/100	033/100	018/100	020/100	015/100	030/100	045/100	038/100	033/100
Wind Velocity/Level (MPH).	8/100	8/100	7/100	7/100	7/100	6/100	5/100	8/100	7/100	7/100	8/100	8/100
Equivalent Airspeed (Knots).	120	127	122	120	120	120	124	126	130	124	128	121
Glide Path Angle (Degrees).	0											
Aircraft Track (Degrees Magnetic).	285	282	284	284	284	284	283	285	285	284	284	283
Aircraft Gross Weight (lb x 1000).	93.5	93.3	93.1	92.9	92.7	92.5	92.3	92.1	91.9	91.7	91.5	91.3
Landing Gear UP or DOWN	D											
Aircraft Configuration[3]	L											
Flap Setting (Degrees).	50											
Wing Spoiler Setting (Degrees).	None											
Engine BMEP #1 (lb/in^2).	140	128	128	135	130	120	130	140	130	135	125	140
Engine RPM.	2500											
Fuel Flow/Engine (lb/hr).	900	780	780	850	820	750	850	750	850	900	750	850
Phototheodolite Operating (Yes, No).	YES											
Peak recorded absolute velocity fps, 1st vtx.	61	42	42	-	-	-	33	56	-	-	-	85
Peak recorded absolute velocity fps, 2nd vtx.	70	124	46	-	-	-	39	96	-	52	-	56
Vortex height on tower, ft, 1st vtx.	65	112	75	-	-	-	-	68	-	-	-	90
Vortex height on tower, ft, 2nd vtx.	57	84	65	-	-	-	-	42	-	98	-	-
Vortex Age, sec, 1st vtx.	17	16	185	-	-	-	32	19.5	-	-	-	21
Vortex Age, sec, 2nd vtx.	23	21.5	27	-	-	-	-	26	-	30	-	30
Mean Descent Rate, fps, 1st vtx.	4.8	4.0	5.1	-	-	-	-	5.3	-	-	-	3.0
Mean Descent Rate, fps, 2nd vtx.	3.9	4.3	3.7	-	-	-	-	5.0	-	1.7	-	-
Mean Lateral Velocity, fps, 1st vtx.	14.6	14.5	13.6	-	-	-	7.8	13.5	-	-	-	11.7
Mean Lateral Velocity, fps, 2nd vtx.	14.8	15.1	12.7	-	-	-	-	13.7	-	11.5	-	11.2
Crosswind Velocity component, fps:	11.0	11.2	9.6	9.1	9.1	8.5	7.0	11.6	9.3	7.8	9.7	10.2
Median Circulation ft^2/sec.	2620	2510	2580	-	-	-	2530	2500	-	2520	-	2550

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SUMMARY FLIGHT TEST DATA SHEET

DATE 9-22-71 AIRCRAFT DC-7 COMPANY FAA REGISTRATION N464

AIRCRAFT CREW Stephens/White/Auer FIELD ELEVATION 76 ft. ATM TURB. LEVEL AT TEST ALT. LIGHT

TEST LOCATION NAFEC 140 ft. Test Tower

Run Number	133	134	135	136								
Time	1010	1014	1018	1022								
Aircraft Position[1] (ft)	290S	292S	310S	300S								
Pressure Altitude ft, Altimeter set to 29.92	140	140	140	140								
Aircraft Height[2] abreast of Tower, ft.	162	166	160	164								
Relative Humidity, percent	71	69	69	69								
Outside Air Temp. (°C), at Test Alt.	16	16	17	17								
Ambient Pressure (Inches Hg).	30.25											
Wind Direction/Level (Degrees True).	032/100	032/100	037/100	035/100								
Wind Velocity/Level (MPH).	10/100	9/100	8/100	7/100								
Equivalent Airspeed (Knots).	121	129	126	126								
Glide Path Angle (Degrees).	0	0	0	0								
Aircraft Track (Degrees Magnetic).	284	284	284	283								
Aircraft Gross Weight (lb x 1000).	91.1	90.9	90.7	90.5								
Landing Gear UP or DOWN	D	D	D	D								
Aircraft Configuration[3]	L	L	L	L								
Flap Setting (Degrees).	50	50	50	50								
Wing Spoiler Setting (Degrees).	NONE											
Engine BMEP #1 (lb/in^2).	150	125	128	125								
Engine RPM.	2500											
Fuel Flow/Engine (lb/hr).	950	800	750	740								
Phototheodolite Operating (Yes/No).	YES											
Peak recorded absolute velocity fps, 1st vtx.	140	82	53	-								
Peak recorded absolute velocity fps, 2nd vtx.	60	84	69	-								
Vortex height on tower, ft, 1st vtx.	75	95	-	-								
Vortex height on tower, ft, 2nd vtx.	-	65	-	-								
Vortex Age, sec, 1st vtx.	17.5	19.5	22.5	-								
Vortex Age, sec, 2nd vtx.	26	24.5	36.5	-								
Mean Descent Rate, fps, 1st vtx.	5.0	3.8	-	-								
Mean Descent Rate, fps, 2nd vtx.	-	4.1	-	-								
Mean Lateral Velocity, fps, 1st vtx.	13.9	13.3	11.7	-								
Mean Lateral Velocity, fps, 2nd vtx.	12.9	13.8	9.8	-								
Crosswind Velocity component, fps:	13.0	11.7	9.8	8.7								
Median Circulation ft^2/sec.	2550	2430	2460	-								

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SUMMARY FLIGHT TEST DATA SHEET

DATE 9-23-71 AIRCRAFT DC-7 COMPANY FAA REGISTRATION N464

AIRCRAFT CREW Bazer/Stephens/Auer FIELD ELEVATION 76 ft. ATM TURB. LEVEL AT TEST ALT. ______

TEST LOCATION NAFEC 140 ft. Test Tower

Run Number	137	138	139	140	141	142	143	144	145	146	147	148
Time	0712	0717	0721	0726	0730	0735	0740	0745	0750	0755	0800	0804
Aircraft Position[1] (ft)	292S	279S	316S	302S	272S	273S	315S	305S	301S	302S	274S	289S
Pressure Altitude ft, Altimeter set to 29.92	130	120	120	115	130	120	100	110	100	100	100	120
Aircraft Height[2] abreast of Tower, ft.	155	168	166	162	155	205	197	162	171	166	168	135
Relative Humidity, percent	79										→	75
Outside Air Temp. (°C), at Test Alt.	15										→	16
Ambient Pressure (Inches Hg).	30.22											→
Wind Direction/Level (Degrees True).	097/100	097/100	095/100	095/100	100/100	105/100	112/100	095/100	092/100	100/100	100/100	108/100
Wind Velocity/Level (MPH).	6/100	8/100	7/100	7/100	8/100	8/100	8/100	8/100	10/100	8/100	8/100	7/100
Equivalent Airspeed (Knots).	127	128	127	128	126	125	128	125	120	123	120	120
Glide Path Angle (Degrees).	0											→
Aircraft Track (Degrees Magnetic).	008	008	008	009	006	012	010	009	005	007	009	008
Aircraft Gross Weight (lb x 1000).	94.2	93.8	93.5	93.2	92.9	92.6	92.3	92.0	91.6	91.3	91.0	90.7
Landing Gear UP or DOWN	D											→
Aircraft Configuration[3]	TO							→	L			→
Flap Setting (Degrees).	20							→	50			→
Wing Spoiler Setting (Degrees).	NONE											→
Engine BMEP #1 (lb/in^2).	145	125	128	120	120	130	135	115	165	155	170	155
Engine RPM.	2500											→
Fuel Flow/Engine (lb/hr).	975	735	750	750	750	760	850	700	1240	1100	1350	1100
Phototheodolite Operating (Yes/No).	YES											→
Peak recorded absolute velocity fps, 1st vtx.	68	86	92	72	56	93	72	81	137	80	66	72
Peak recorded absolute velocity fps, 2nd vtx.	40	36	36	56	37	48	40	38	52	124	102	56
Vortex height on tower, ft, 1st vtx.	-	123	86	74	100	115	131	95	123	102	123	75
Vortex height on tower, ft, 2nd vtx.	-	110	86	48	80	83	86	99	95	73	78	53
Vortex Age, sec, 1st vtx.	18.5	16	22	22	15.5	15	17.5	14	16	18	13.5	15
Vortex Age, sec, 2nd vtx.	26.5	21	32	30	22.5	21.5	25	19	23	27	20.5	23.5
Mean Descent Rate, fps, 1st vtx.	-	2.8	3.6	4.0	3.6	6.0	3.8	4.8	3.0	3.6	3.3	4.0
Mean Descent Rate, fps, 2nd vtx.	-	2.8	2.5	3.8	3.3	5.7	4.4	3.3	3.3	3.4	4.9	3.5
Mean Lateral Velocity, fps, 1st vtx.	13.3	14.6	12.3	11.6	14.6	15.1	15.6	18.5	15.9	14.2	16.9	16.2
Mean Lateral Velocity, fps, 2nd vtx.	12.8	15.5	11.3	11.6	14.1	14.8	14.4	18.5	15.1	12.9	15.6	14.3
Crosswind Velocity component, fps:	8.7	11.6	10.2	10.2	11.4	11.4	10.9	11.7	14.6	11.4	11.5	9.6
Median Circulation ft^2/sec.	2420	2400	2400	2390	2410	2420	2360	2400	2580	2520	2560	2560

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SUMMARY FLIGHT TEST DATA SHEET

DATE 9-23-71 AIRCRAFT DC-7 COMPANY FAA REGISTRATION N464

AIRCRAFT CREW Bazer/Stephens/Auer FIELD ELEVATION 76 ft. ATM TURB. LEVEL AT TEST ALT. ______

TEST LOCATION NAFEC 140 ft. Test Tower

Run Number	149	150	151	152								
Time	0809	0813	0818	0823								
Aircraft Position[1] (ft)	286S	293S	276S	280S								
Pressure Altitude ft, Altimeter set to 29.92	110	120	100	130								
Aircraft Height[2] abreast of Tower, ft.	154	147	168	159								
Relative Humidity, percent	73	→	→	→								
Outside Air Temp. (°C), at Test Alt.	16	17	→	→								
Ambient Pressure (Inches Hg).	30.22	→	→	→								
Wind Direction/Level (Degrees True).	100/100	100/100	107/100	112/100								
Wind Velocity/Level (MPH).	11/100	8/100	9/100	8/100								
Equivalent Airspeed (Knots).	122	119	118	117								
Glide Path Angle (Degrees).	0	→	→	→								
Aircraft Track (Degrees Magnetic).	007	008	010	006								
Aircraft Gross Weight (lb x 1000).	90.4	90.1	89.9	89.2								
Landing Gear UP or DOWN	D	→	→	→								
Aircraft Configuration[3]	L	→	→	→								
Flap Setting (Degrees).	50	→	→	→								
Wing Spoiler Setting (Degrees).	NONE	→	→	→								
Engine BMEP #1 (lb/in^2).	160	155	150	170								
Engine RPM.	2500	→	→	→								
Fuel Flow/Engine (lb/hr).	1150	1100	1000	1250								
Phototheodolite Operating (Yes/No).	YES	→	→	→								
Peak recorded absolute velocity fps, 1st vtx.	58	56	85	52								
Peak recorded absolute velocity fps, 2nd vtx.	90	94	78	127								
Vortex height on tower, ft, 1st vtx.	119	110	102	106								
Vortex height on tower, ft, 2nd vtx.	90	91	94	91								
Vortex Age, sec, 1st vtx.	15	13	14	14								
Vortex Age, sec, 2nd vtx.	21.5	17	21	20								
Mean Descent Rate, fps, 1st vtx.	2.3	2.9	4.7	3.8								
Mean Descent Rate, fps, 2nd vtx.	3.0	3.3	3.5	3.4								
Mean Lateral Velocity, fps, 1st vtx.	16.0	19.0	16.4	16.7								
Mean Lateral Velocity, fps, 2nd vtx.	15.4	19.0	15.3	16.3								
Crosswind Velocity component, fps:	15.7	11.5	12.6	10.5								
Median Circulation ft^2/sec.	2510	2550	2560	2560								

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SUMMARY FLIGHT TEST DATA SHEET

DATE 9-23-71 AIRCRAFT DC-7 COMPANY FAA REGISTRATION N464

AIRCRAFT CREW Bazer/Stephens/Auer FIELD ELEVATION 76 ft. ATM TURB. LEVEL AT TEST ALT. ____

TEST LOCATION NAFEC 140 ft. Test Tower

Run Number	153	154	155	156	157	158	159	160	161	162	163	164
Time	0942	0947	0952	0957	1015	1020	1023	1028	1032	1037	1042	1046
Aircraft Position[1] (ft)	283S	277S	284S	271S	223S	199S	186S	285S	295S	285S	283S	289S
Pressure Altitude ft, Altimeter set to 29.92	120	120	140	130	120	150	150	160	140	120	150	140
Aircraft Height[2] abreast of Tower, ft.	166	162	143	153	151	136	141	141	147	154	136	140
Relative Humidity, percent	77											→
Outside Air Temp. (°C), at Test Alt.	18											→
Ambient Pressure (Inches Hg).	30.22											→
Wind Direction/Level (Degrees True).	125/100	120/100	120/100	118/100	120/100	125/100	120/100	123/100	125/100	135/100	135/100	130/100
Wind Velocity/Level (MPH).	5/100	4/100	5/100	5/100	5/100	5/100	6/100	6/100	6/100	6/100	6/100	7/100
Equivalent Airspeed (Knots).	122	123	126	125	128	124	123	125	118	115	117	127
Glide Path Angle (Degrees).	0											→
Aircraft Track (Degrees Magnetic).	010	010	008	009	041	040	040	039	050	050	039	039
Aircraft Gross Weight (lb x 1000).	95.0	94.7	94.4	94.1	93.8	93.5	93.2	92.9	92.5	92.1	91.7	91.3
Landing Gear UP or DOWN	D											→
Aircraft Configuration[3]	TO							→	L			→
Flap Setting (Degrees).	20							→	50			→
Wing Spoiler Setting (Degrees).	NONE											→
Engine BMEP #1 (lb/in^2).	130	115	120	120	112	110	125	120	155	150	160	145
Engine RPM.	2500											→
Fuel Flow/Engine (lb/hr).	875	700	730	730	680	650	750	700	1100	1050	1200	950
Phototheodolite Operating (Yes/No).	YES											→
Peak recorded absolute velocity fps, 1st vtx.	78	71	82	60	77	58	49	47	72	75	140	140
Peak recorded absolute velocity fps, 2nd vtx.	44	42	44	40	43	40	37	47	62	54	54	96
Vortex height on tower, ft, 1st vtx.	82	79	103	79	118	100	117	75	93	118	121	85
Vortex height on tower, ft, 2nd vtx.	107	81	48	74	91	74	74	65	86	70	89	79
Vortex Age, sec, 1st vtx.	15	17	19.5	14	11	10	9	14	14	13.5	11	9.5
Vortex Age, sec, 2nd vtx.	24	24	28.5	21	17	17	16	18	19	20	16	13.5
Mean Descent Rate, fps, 1st vtx.	5.6	4.8	2.1	5.3	3.0	3.6	2.7	4.7	3.9	2.7	1.4	5.8
Mean Descent Rate, fps, 2nd vtx.	2.5	3.3	3.3	3.8	3.5	3.7	4.2	4.2	3.2	4.2	2.9	4.5
Mean Lateral Velocity, fps, 1st vtx.	15.8	13.6	12.2	16.1	16.1	15.3	15.6	17.1	17.8	17.7	21.5	25.6
Mean Lateral Velocity, fps, 2nd vtx.	13.7	13.5	11.6	15.1	15.8	14.4	14.5	18.4	17.9	16.6	20.6	24.8
Crosswind Velocity component, fps:	6.0	5.1	6.2	6.4	7.3	7.3	6.8	8.0	8.8	8.5	8.5	10.1
Median Circulation ft^2/sec.	2520	2520	2440	2450	2400	2450	2460	2420	2630	2670	2360	2460

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SUMMARY FLIGHT TEST DATA SHEET

DATE 9-23-71 AIRCRAFT DC-7 COMPANY FAA REGISTRATION N464

AIRCRAFT CREW Bazer/Stephens/Auer FIELD ELEVATION 76 ft. ATM TURB. LEVEL AT TEST ALT. ____

TEST LOCATION NAFEC 140 ft. Test Tower

Run Number	165	166	167	168								
Time	1051	1055	1100	1105								
Aircraft Position[1] (ft)	291S	289S	353S	363S								
Pressure Altitude ft, Altimeter set to 29.92	130	120	140	100								
Aircraft Height[2] abreast of Tower, ft.	145	150	130	168								
Relative Humidity, percent	77											
Outside Air Temp. (°C), at Test Alt.	18											
Ambient Pressure (Inches Hg).	30.22											
Wind Direction/Level (Degrees True).	135/100	135/100	135/100	140/100								
Wind Velocity/Level (MPH).	9/100	15/100	9/100	9/100								
Equivalent Airspeed (Knots).	120	122	120	119								
Glide Path Angle (Degrees).	0											
Aircraft Track (Degrees Magnetic).	039	039	038	043								
Aircraft Gross Weight (lb x 1000).	90.9	90.6	90.3	90.0								
Landing Gear UP or DOWN	D											
Aircraft Configuration[3]	L											
Flap Setting (Degrees).	50											
Wing Spoiler Setting (Degrees).	NONE											
Engine BMEP #1 (lb/in²).	170	168	150	168								
Engine RPM.	2500											
Fuel Flow/Engine (lb/hr).	1200	1180	1000	1180								
Phototheodolite Operating (Yes/No).	YES											
Peak recorded absolute velocity fps, 1st vtx.	80	102	140	80								
Peak recorded absolute velocity fps, 2nd vtx.	140	99	140	100								
Vortex height on tower, ft, 1st vtx.	112	109	94	119								
Vortex height on tower, ft, 2nd vtx.	90	105	35	109								
Vortex Age, sec, 1st vtx.	10.5	8	12	14.5								
Vortex Age, sec, 2nd vtx.	14.5	11	17.5	19								
Mean Descent Rate, fps, 1st vtx.	3.1	5.1	3.[illegible]	3.4								
Mean Descent Rate, fps, 2nd vtx.	3.8	4.1	5.4	3.1								
Mean Lateral Velocity, fps, 1st vtx.	23.3	30.4	25.6	21.9								
Mean Lateral Velocity, fps, 2nd vtx.	23.2	30.5	22.8	21.5								
Crosswind Velocity component, fps:	12.7	21.2	12.6	12.6								
Median Circulation ft²/sec.	2560	2520	2540	2550								

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SUMMARY FLIGHT TEST DATA SHEET

DATE 9-24-71 AIRCRAFT DC-7 COMPANY FAA REGISTRATION N464

AIRCRAFT CREW Bazer/Stephens/Auer FIELD ELEVATION 76 ft. ATM TURB. LEVEL AT TEST ALT. ______

TEST LOCATION NAFEC 140 ft. Test Tower

Run Number	169	170	171	172	173	174	175	176	177	178	179	180
Time	0720	0727	0732	0738	0748	0754	0758	0803	0807	0812	0828	0833
Aircraft Position[1] (ft)	400P	291P	328P	307P	418P	268P	259P	332P	340P	321P	321S	323S
Pressure Altitude ft, Altimeter set to 29.92	40	40	40	40	40	40	40	30	10	20	40	60
Aircraft height[2] abreast of Tower, ft.	140	177	152	142	150	152	154	168	180	171	154	156
Relative Humidity, percent	97										→	86
Outside Air Temp. (°C), at Test Alt.	12	12	13	13	14	14	15					→
Ambient Pressure (Inches Hg).	30.12											→
Wind Direction/Level (Degrees True).	345/100	335/100	337/100	337/100	350/100	350/100	350/100	347/100	360/100	345/100	350/100	360/100
Wind Velocity/Level (MPH).	8/100	7/100	8/100	9/100	9/100	10/100	12/100	11/100	16/100	11/100	14/100	13/100
Equivalent Airspeed (Knots).	128	125	125	124	125	128	120	124	120	120	120	120
Glide Path Angle (Degrees).	0											→
Aircraft Track (Degrees Magnetic).	040	038	032	043	034	051	035	039	037	039	274	273
Aircraft Gross Weight (lb x 1000).	94.7	94.4	94.0	93.6	93.2	92.9	92.5	92.2	91.9	91.6	90.8	90.5
Landing Gear UP or DOWN	D											→
Aircraft Configuration[3]	TO							→	L			→
Flap Setting (Degrees).	20							→	50			→
Wing Spoiler Setting (Degrees).	NONE											→
Engine BMEF #1 (lb/in²).	125	110	105	120	105	90	90	105	120	160	165	125
Engine RPM.	2500											→
Fuel Flow/Engine (lb/hr).	730	650	600	750	600	500	500	600	700	1100	1150	750
Phototheodolite Operating (Yes/No).	YES											→
Peak recorded absolute velocity fps, 1st vtx.	-	46	59	48	60	42	45	47	90	58	140	-
Peak recorded absolute velocity fps, 2nd vtx.	-	38	94	111	-	58	36	47	44	60	62	-
Vortex height on tower, ft, 1st vtx.	-	99	88	93	70	107	73	106	106	119	94	-
Vortex height on tower, ft, 2nd vtx.	-	80	87	90	-	102	70	70	66	114	114	-
Vortex Age, sec, 1st vtx.	-	16	22	[illegible]	22	14	14	15.5	19	16.5	13	-
Vortex Age, sec, 2nd vtx.	-	25	28	25	-	17	17.5	22.5	23	22	18.5	-
Mean Descent Rate, fps, 1st vtx.	-	4.9	2.9	2.9	3.6	3.2	5.8	4.0	3.9	3.2	4.6	-
Mean Descent Rate, fps, 2nd vtx.	-	3.9	2.3	2.1	-	2.9	4.8	4.4	5.0	2.6	2.2	-
Mean Lateral Velocity, fps, 1st vtx.	-	15.3	12.8	15.4	16.9	15.9	15.2	18.5	15.5	16.7	21.2	-
Mean Lateral Velocity, fps, 2nd vtx.	-	13.5	13.4	14.1	-	18.5	17.4	16.8	16.8	16.7	19.8	-
Crosswind Velocity component, fps:	8.3	8.2	8.3	10.9	7.4	11.4	10.1	10.8	10.7	11.2	20.5	18.9
Median Circulation ft²/sec.	-	2460	2440	2460	2430	2380	2500	2420	2580	2580	2560	-

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[3]TO = Take-off, H = Holding, L = Landing, App = Approach.

SUMMARY FLIGHT TEST DATA SHEET

DATE 9-24-71 AIRCRAFT DC-7 COMPANY FAA REGISTRATION N464

AIRCRAFT CREW Bazer/Stephens/Auer FIELD ELEVATION 76 ft. ATM TURB. LEVEL AT TEST ALT. ______

TEST LOCATION NAFEC 140 ft. Test Tower

Run Number	181	182	183	184								
Time	0837	0841	0846	0850								
Aircraft Position[1] (ft)	333S	391S	397S	377S								
Pressure Altitude ft, Altimeter set to 29.92	40	40	40	40								
Aircraft height[2] abreast of Tower, ft.	164	172	159	151								
Relative Humidity, percent	86	→	→	→								
Outside Air Temp. (°C), at Test Alt.	15	→	→	→								
Ambient Pressure (Inches Hg).	30.13	→	→	→								
Wind Direction/Level (Degrees True).	352/100	352/100	355/100	360/100								
Wind Velocity/Level (MPH).	11/100	18/100	17/100	18/100								
Equivalent Airspeed (Knots).	118	118	120	118								
Glide Path Angle (Degrees).	0	→	→	→								
Aircraft Track (Degrees Magnetic).	271	268	271	274								
Aircraft Gross Weight (lb x 1000).	90.2	89.9	89.6	89.3								
Landing Gear UP or DOWN	D	→	→	→								
Aircraft Configuration[3]	L	→	→	→								
Flap Setting (Degrees).	50	→	→	→								
Wing Spoiler Setting (Degrees).	NONE	→	→	→								
Engine BMEP #1 (lb/in^2).	165	140	130	140								
Engine RPM.	2500	→	→	→								
Fuel Flow/Engine (lb/hr).	1150	900	800	900								
Phototheodolite Operating (Yes/No).	YES	→	→	→								
Peak recorded absolute velocity fps, 1st vtx.	88	67	-	100								
Peak recorded absolute velocity fps, 2nd vtx.	86	-	-	30								
Vortex height on tower, ft, 1st vtx.	127	80	-	93								
Vortex height on tower, ft, 2nd vtx.	106	-	-	64								
Vortex Age, sec, 1st vtx.	13	14	-	10								
Vortex Age, sec, 2nd vtx.	16	-	-	12.5								
Mean Descent Rate, fps, 1st vtx.	2.9	6.6	-	5.8								
Mean Descent Rate, fps, 2nd vtx.	3.6	-	-	7.0								
Mean Lateral Velocity, fps, 1st vtx.	22.1	24.6	-	33.1								
Mean Lateral Velocity, fps, 2nd vtx.	23.7	-	-	33.8								
Crosswind Velocity component, fps:	16.1	26.4	24.9	26.4								
Median Circulation ft^2/sec.	2570	2560	2520	2550								

[1]Aircraft C/L Lateral Offset (ft), from tower. P = To port of tower. S = To starboard of tower.

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SUMMARY FLIGHT TEST DATA SHEET

DATE 9-24-71 AIRCRAFT DC-7 COMPANY FAA REGISTRATION N464

AIRCRAFT CREW Bazer/Stephens/Auer FIELD ELEVATION 76 ft. ATM TURB. LEVEL AT TEST ALT. ______

TEST LOCATION NAFEC 140 ft. Test Tower

Run Number	185	186	187	188	189	190	191	192	193	194	195	196
Time	1012	1017	1021	1025	1028	1032	1035	1038	1042	1046	1050	1054
Aircraft Position[1] (ft)	413S	469S	441S	409S	424S	402S	422S	422S	423S	437S	436S	418S
Pressure Altitude ft, Altimeter set to 29.92	120	100	90	100	100	90	100	80	90	60	80	70
Aircraft Height[2] abreast of Tower, ft.	146	156	155	140	140	150	149	151	131	172	148	165
Relative humidity, percent	65	65	63	63	63	65	65	65	63	61	61	59
Outside Air Temp. (°C), at Test Alt.	15											→
Ambient Pressure (Inches Hg).	30.17											→
Wind Direction/Level (Degrees True).	360/100	355/100	360/100	355/100	350/100	360/100	360/100	360/100	353/100	355/100	355/100	355/100
Wind Velocity/Level (MPH).	18/100	18/100	15/100	15/100	18/100	15/100	18/100	15/100	13/100	14/100	15/100	15/100
Equivalent Airspeed (Knots).	124	126	126	126	124	120	130	124	120	120	115	118
Glide Path Angle (Degrees).	0											→
Aircraft Track (Degrees Magnetic).	267	270	272	274	274	275	273	273	274	275	276	275
Aircraft Gross Weight (lb x 1000).	94.8	94.6	94.4	94.2	94.0	93.8	93.6	93.4	93.2	93.0	92.8	92.6
Landing Gear UP or DOWN	D											→
Aircraft Configuration[3]	TO							→	L			→
Flap Setting (Degrees).	20							→	50			→
Wing Spoiler Setting (Degrees).	NONE											→
Engine BMEP #1 (lb/in^2).	110	120	90	110	95	110	110	120	170	165	140	160
Engine RPM.	2500											→
Fuel Flow/Engine (lb/hr).	700	750	550	700	600	700	700	750	1275	1200	900	1150
Phototheodolite Operating (Yes/No).	YES											→
Peak recorded absolute velocity fps, 1st vtx.	66	52	50	68	59	45	108	46	-	78	117	95
Peak recorded absolute velocity fps, 2nd vtx.	-	64	56	50	57	51	46	55	-	52	-	54
Vortex height on tower, ft, 1st vtx.	62	111	107	65	100	94	115	86	-	86	135	140
Vortex height on tower, ft, 2nd vtx.	-	78	47	39	58	91	100	58	-	94	-	87
Vortex Age, sec, 1st vtx.	15	13	15	13	15	17	13	16	-	17	16	16
Vortex Age, sec, 2nd vtx.	-	17	21	17	19	22	17	22	-	18.5	-	20
Mean Descent Rate, fps, 1st vtx.	5.6	3.5	3.2	5.8	2.7	3.3	2.6	4.1	-	5.1	0.8	1.6
Mean Descent Rate, fps, 2nd vtx.	-	4.6	5.1	5.9	4.3	2.7	2.9	4.2	-	4.2	-	3.9
Mean Lateral Velocity, fps, 1st vtx.	24.5	32.5	26.3	27.9	25.2	20.9	28.9	23.5	-	23.0	24.4	23.2
Mean Lateral Velocity, fps, 2nd vtx.	-	30.3	23.2	26.8	24.7	20.4	27.5	21.3	-	26.1	-	23.2
Crosswind Velocity component, fps:	25.7	26.3	21.8	22.0	26.3	21.9	26.2	21.8	19.1	20.5	23.5	22.0
Median Circulation ft^2/sec.	2480	2450	2450	2440	2460	2530	2360	2450	2610	2610	2690	2640

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SUMMARY FLIGHT TEST DATA SHEET

DATE 9-24-71 AIRCRAFT DC-7 COMPANY FAA REGISTRATION N464

AIRCRAFT CREW Bazer/Stephens/Auer FIELD ELEVATION 76 ft. ATM TURB. LEVEL AT TEST ALT. ________

TEST LOCATION NAFEC 140 ft. Test Tower

Run Number	197	198	199	200								
Time	1057	1101	1105	1108								
Aircraft Position[1] (ft)	402S	418S	422S	396S								
Pressure Altitude ft, Altimeter set to 29.92	82	60	80	60								
Aircraft height[2] abreast of Tower, ft.	154	166	155	171								
Relative Humidity, percent	59	59	59	60								
Outside Air Temp. (°C), at Test Alt.	15			→								
Ambient Pressure (Inches Hg).	30.17			→								
Wind Direction/Level (Degrees True).	015/100	357/100	012/100	360/100								
Wind Velocity/Level (MPH).	16/100	12/100	17/100	16/100								
Equivalent Airspeed (Knots).	121	115	119	118								
Glide Path Angle (Degrees).	0	0	0	0								
Aircraft Track (Degrees Magnetic).	274	273	275	274								
Aircraft Gross Weight (lb x 1000).	92.4	92.2	92.0	91.8								
Landing Gear UP or DOWN	D			→								
Aircraft Configuration[3]	L			→								
Flap Setting (Degrees).	50			→								
Wing Spoiler Setting (Degrees).	NONE			→								
Engine BMEP #1 (lb/in^2).	165	170	150	165								
Engine RPM.	2500			→								
Fuel Flow/Engine (lb/hr).	1150	1250	1000	1150								
Phototheodolite Operating (Yes/No).	YES			→								
Peak recorded absolute velocity fps, 1st vtx.	60	50	64	60								
Peak recorded absolute velocity fps, 2nd vtx.	130	109	66	140								
Vortex height on tower, ft, 1st vtx.	106	58	72	65								
Vortex height on tower, ft, 2nd vtx.	86	50	70	85								
Vortex Age, sec, 1st vtx.	12	17	16	14								
Vortex Age, sec, 2nd vtx.	17	23	20	17								
Mean Descent Rate, fps, 1st vtx.	4.0	6.4	5.2	7.6								
Mean Descent Rate, fps, 2nd vtx.	4.0	5.0	4.3	5.1								
Mean Lateral Velocity, fps, 1st vtx.	29.7	21.9	23.5	25.0								
Mean Lateral Velocity, fps, 2nd vtx.	26.4	20.2	23.4	26.0								
Crosswind Velocity component, fps:	21.9	17.6	23.8	23.4								
Median Circulation ft^2/sec.	2580	2680	2600	2610								

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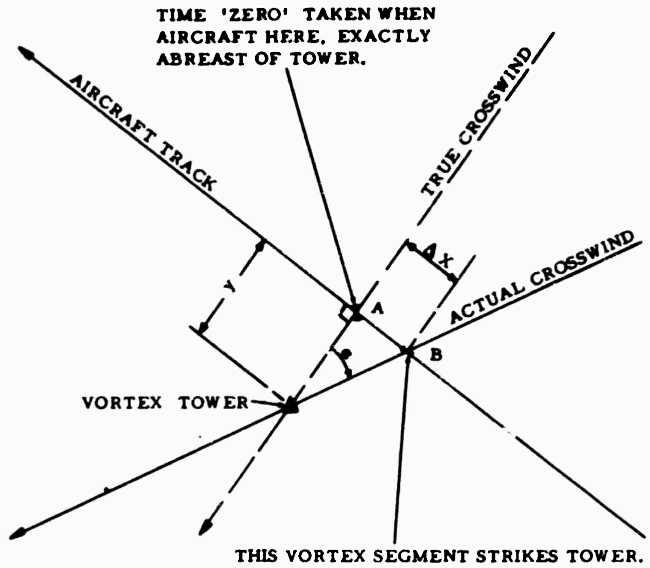
APPENDIX H

DETERMINATION OF ERROR INTRODUCED WHEN WIND IS NOT EXACT CROSSWIND

DETERMINATION OF ERROR INTRODUCED WHEN WIND IS NOT EXACT CROSSWIND



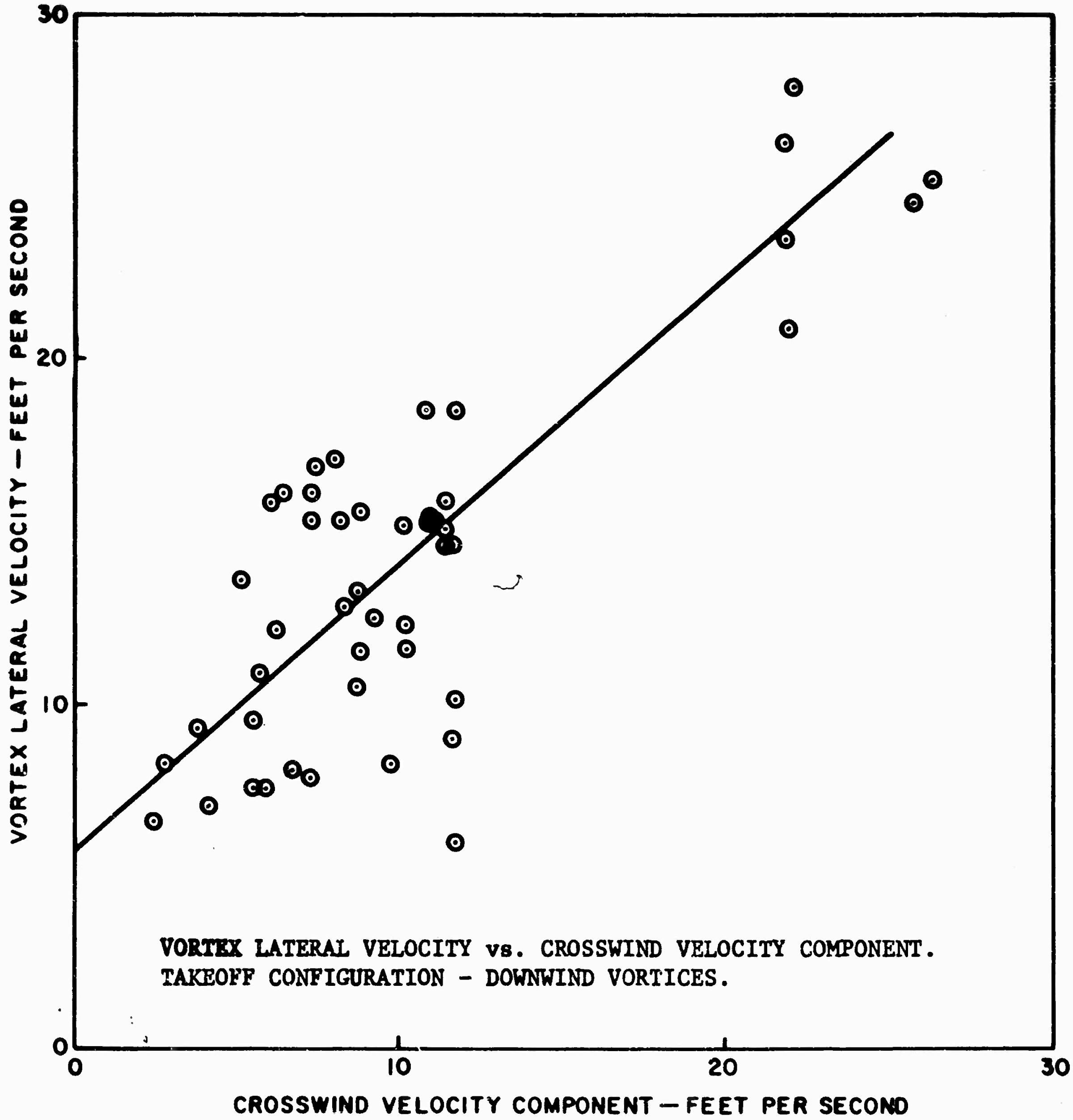
NOTE: In performing vortex tower measurements, it is usually not possible for the aircraft track to be selected exactly at right angles to the wind. The exact wind direction and strength is difficult to determine and usually will not be constant over the height of the tower anyway.

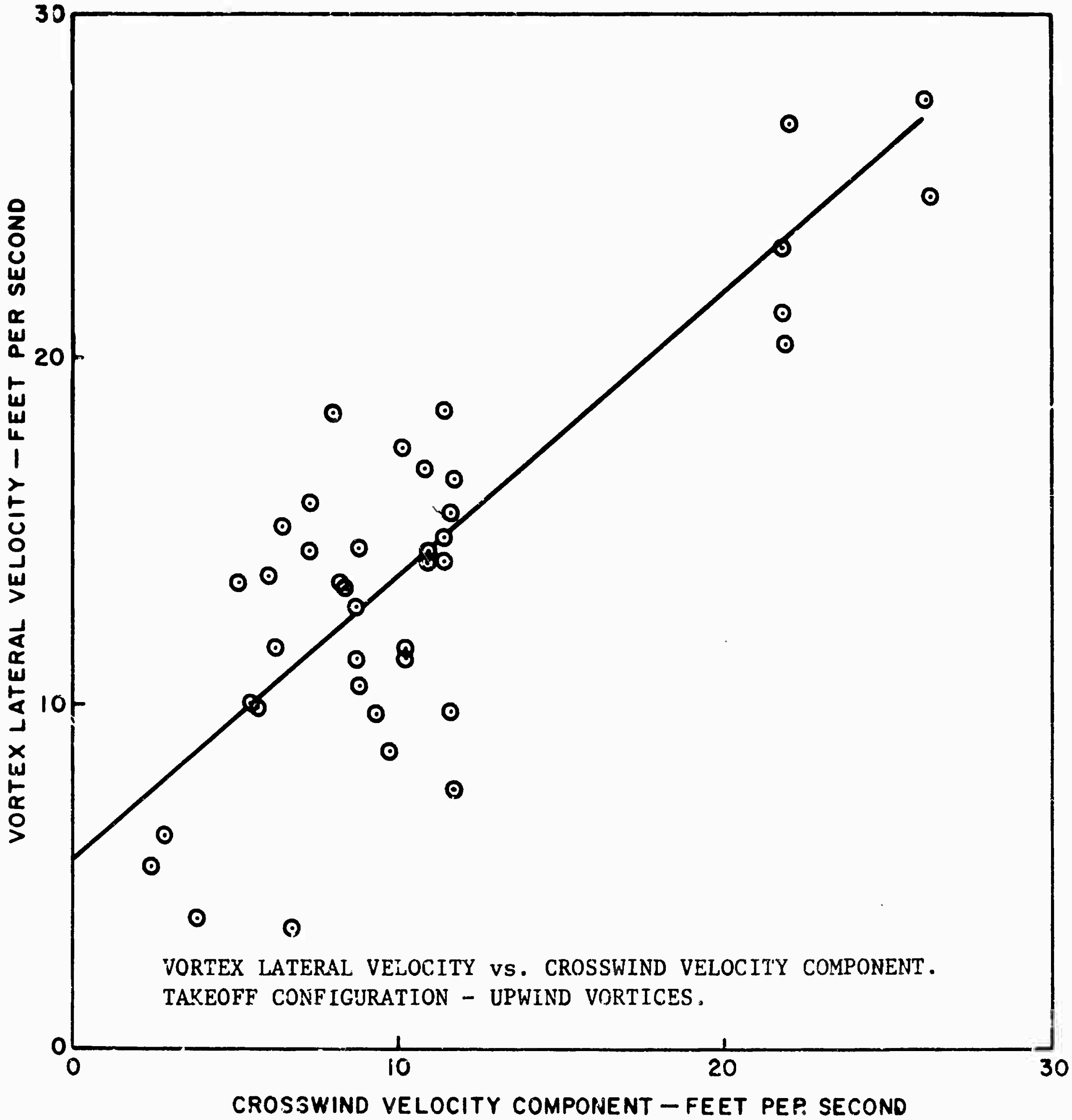
Time "zero" is selected as that time when the airplane is exactly abreast of the tower (point 'A'), but the vortex segment that strikes the tower is that generated at 'B.' Time "zero" then, should, strictly speaking, be taken when the airplane is at 'B,' so an error is introduced equal to the time the airplane takes to fly from B to A. For the case shown, time "zero" will be late. The error in vortex "age" is not large. For example, for $y = 300$ ft, $\alpha = 30°$, the distance Δx is 173 feet - which at 120 knots groundspeed, takes approximately 0.9 second.

The calculation of lateral transport velocities is thus slightly in error too - but the determination of crosswind velocity component is not affected - it is as accurate or inaccurate as the measurement of the wind strength and direction.

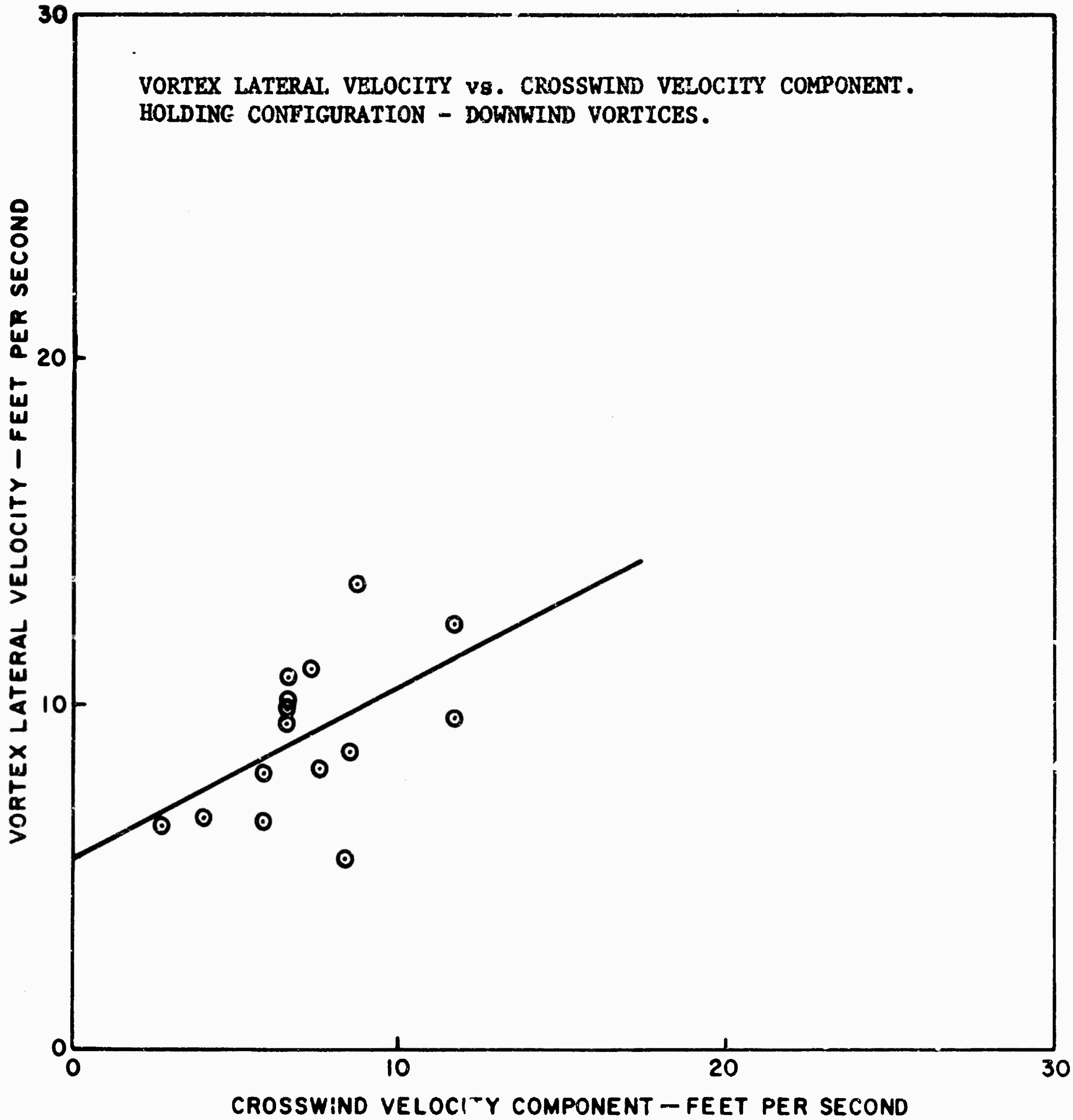
APPENDIX I

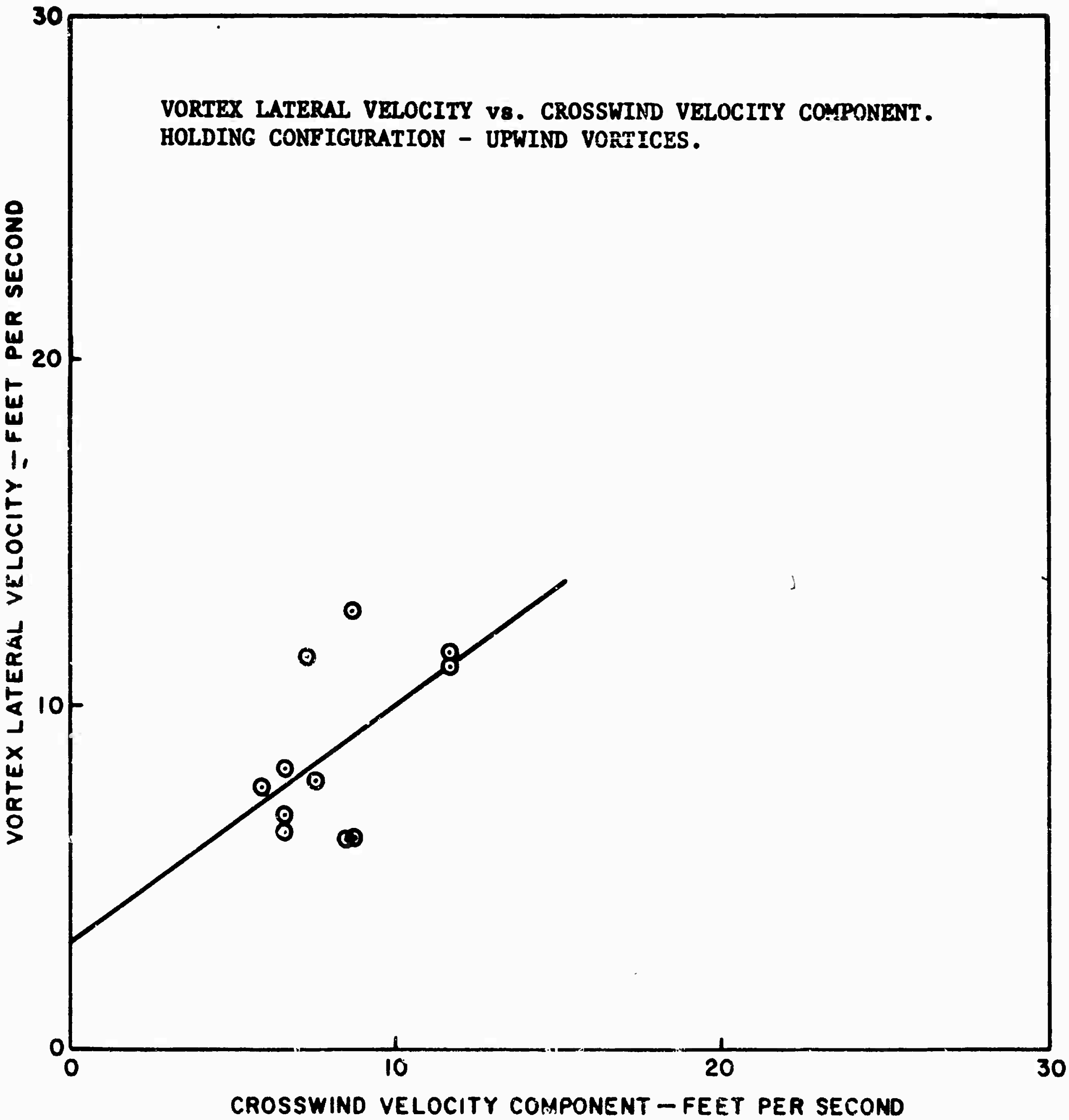
GRAPHS OF VORTEX VELOCITIES

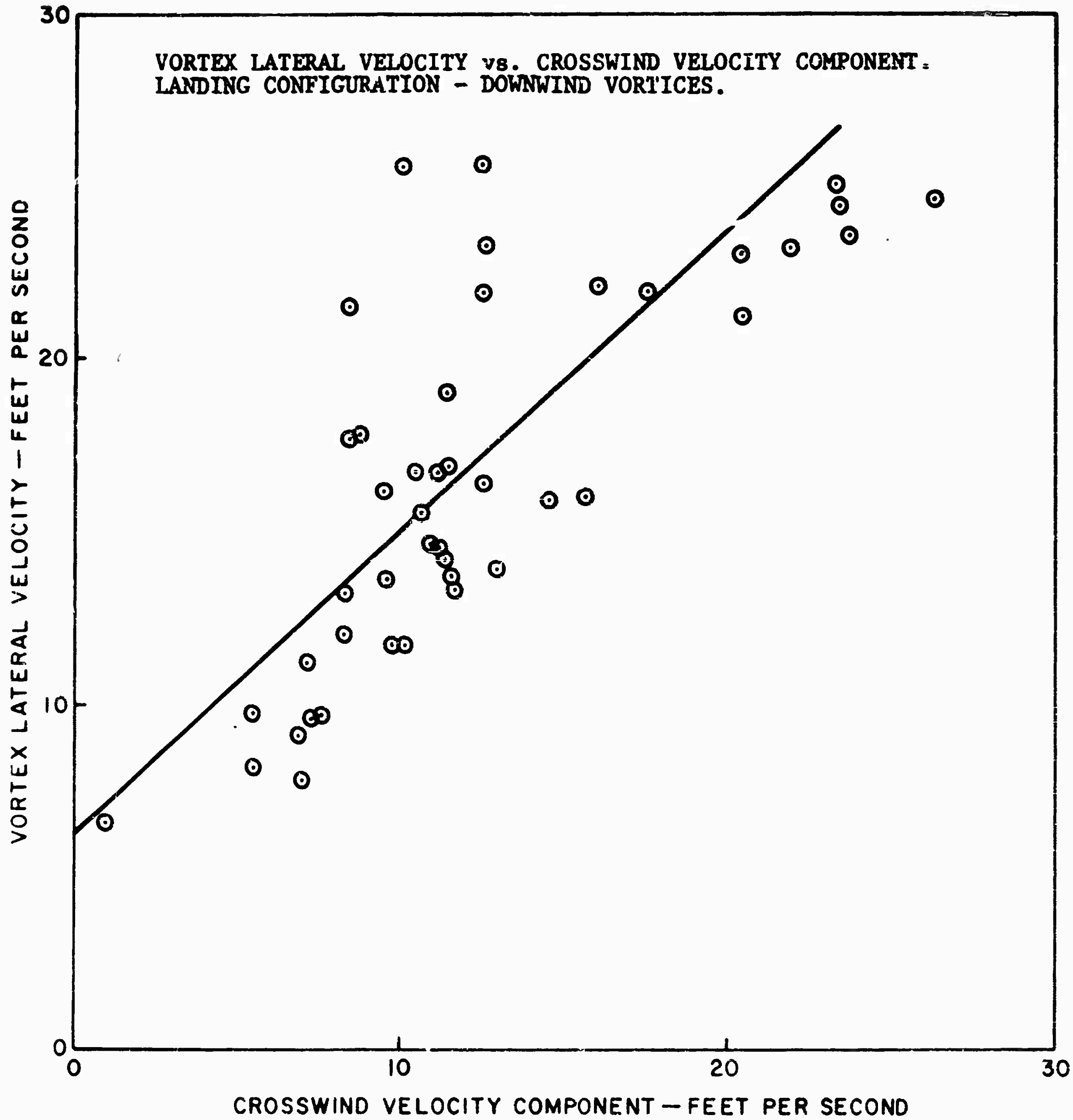

VORTEX LATERAL VELOCITY vs. CROSSWIND VELOCITY COMPONENT.
TAKEOFF CONFIGURATION - DOWNWIND VORTICES.
VORTEX LATERAL VELOCITY — FEET PER SECOND
CROSSWIND VELOCITY COMPONENT — FEET PER SECOND
0
10
20
30

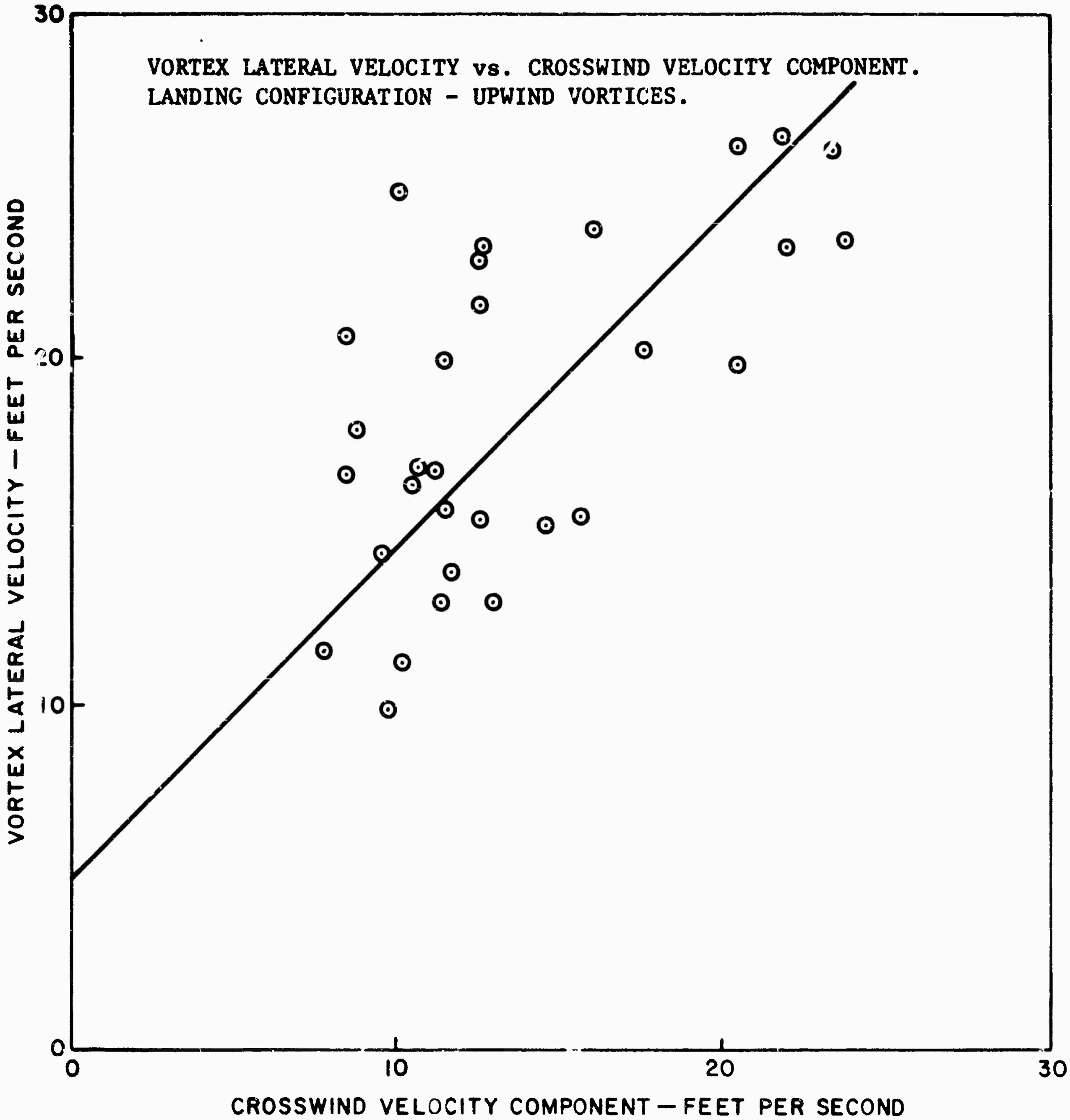


VORTEX LATERAL VELOCITY vs. CROSSWIND VELOCITY COMPONENT. TAKEOFF CONFIGURATION - UPWIND VORTICES.

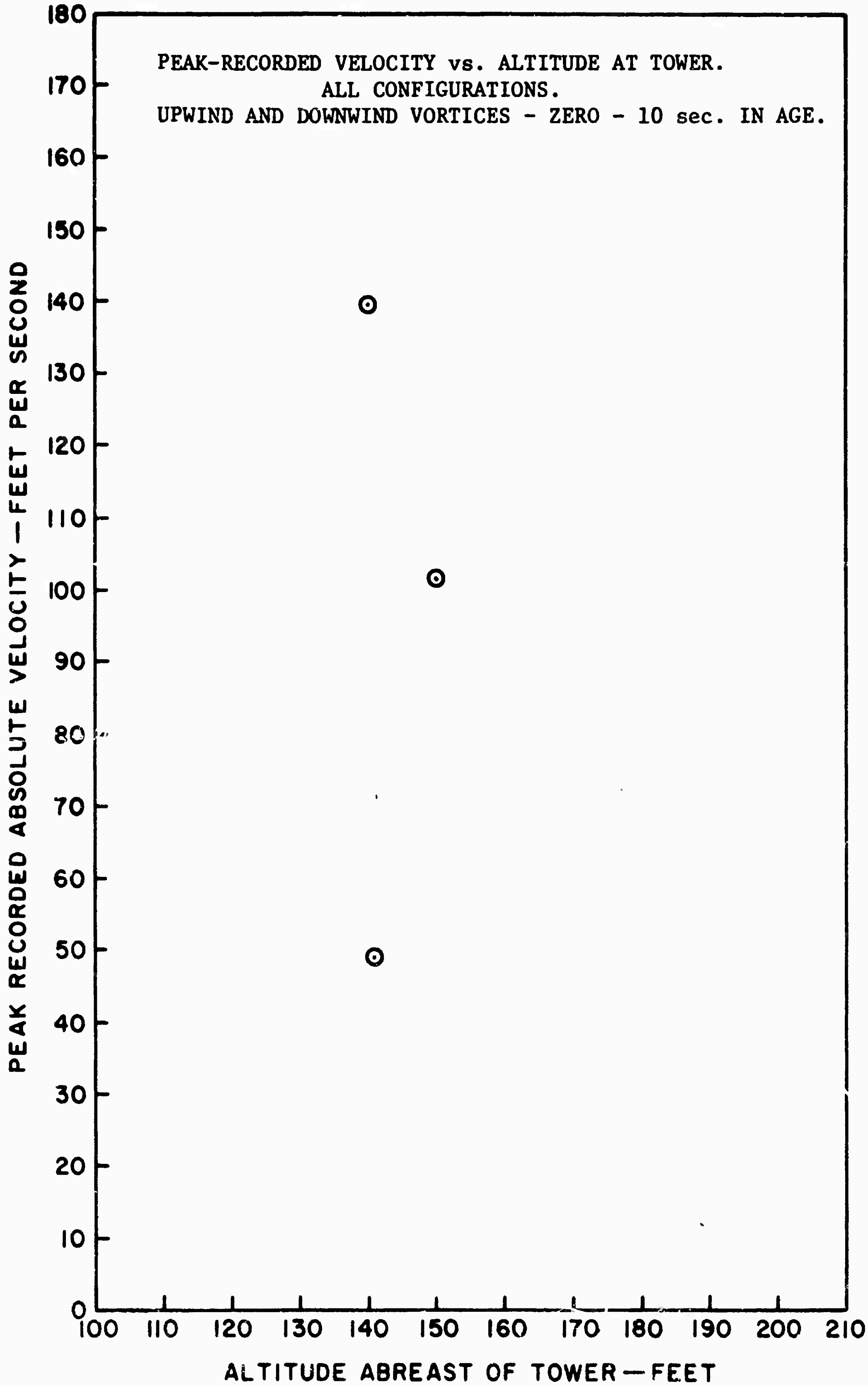

VORTEX LATERAL VELOCITY vs. CROSSWIND VELOCITY COMPONENT.
HOLDING CONFIGURATION - DOWNWIND VORTICES.
30
20
10
0
0
10
20
30
VORTEX LATERAL VELOCITY — FEET PER SECOND
CROSSWIND VELOCITY COMPONENT — FEET PER SECOND

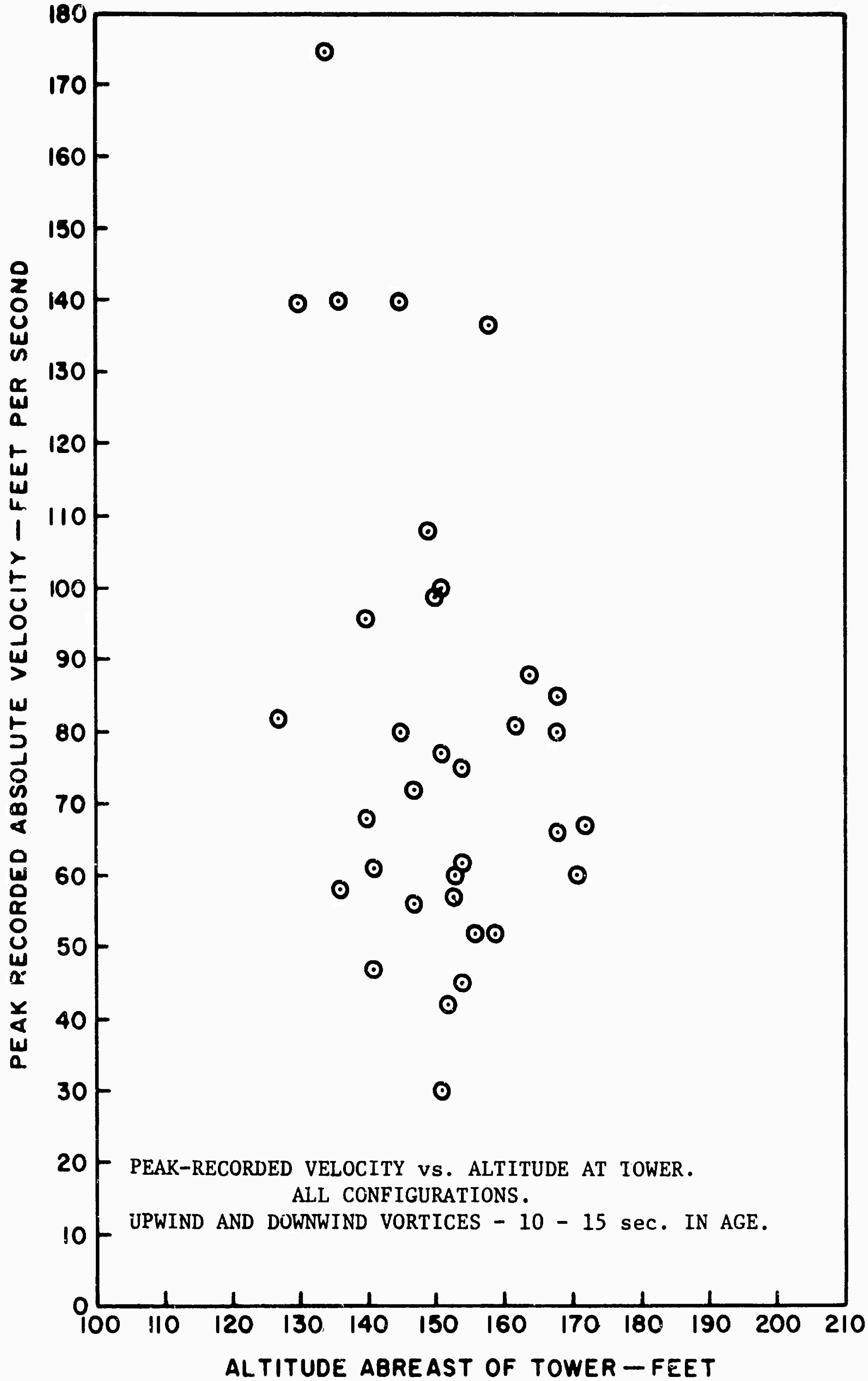

VORTEX LATERAL VELOCITY vs. CROSSWIND VELOCITY COMPONENT.
HOLDING CONFIGURATION - UPWIND VORTICES.
VORTEX LATERAL VELOCITY — FEET PER SECOND
CROSSWIND VELOCITY COMPONENT — FEET PER SECOND
0
10
20
30

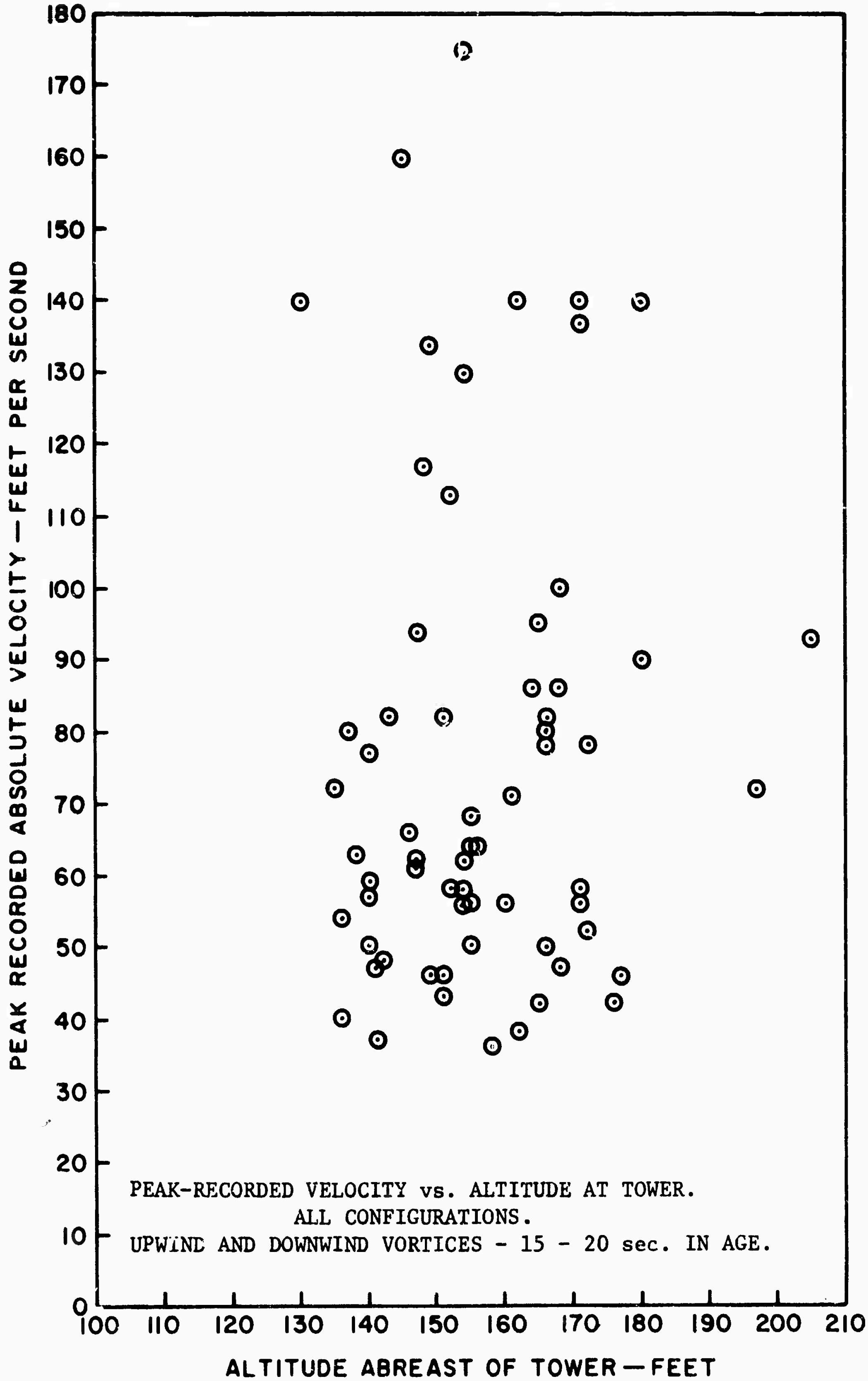

VORTEX LATERAL VELOCITY vs. CROSSWIND VELOCITY COMPONENT.
LANDING CONFIGURATION - DOWNWIND VORTICES.
VORTEX LATERAL VELOCITY — FEET PER SECOND
CROSSWIND VELOCITY COMPONENT — FEET PER SECOND
0
10
20
30



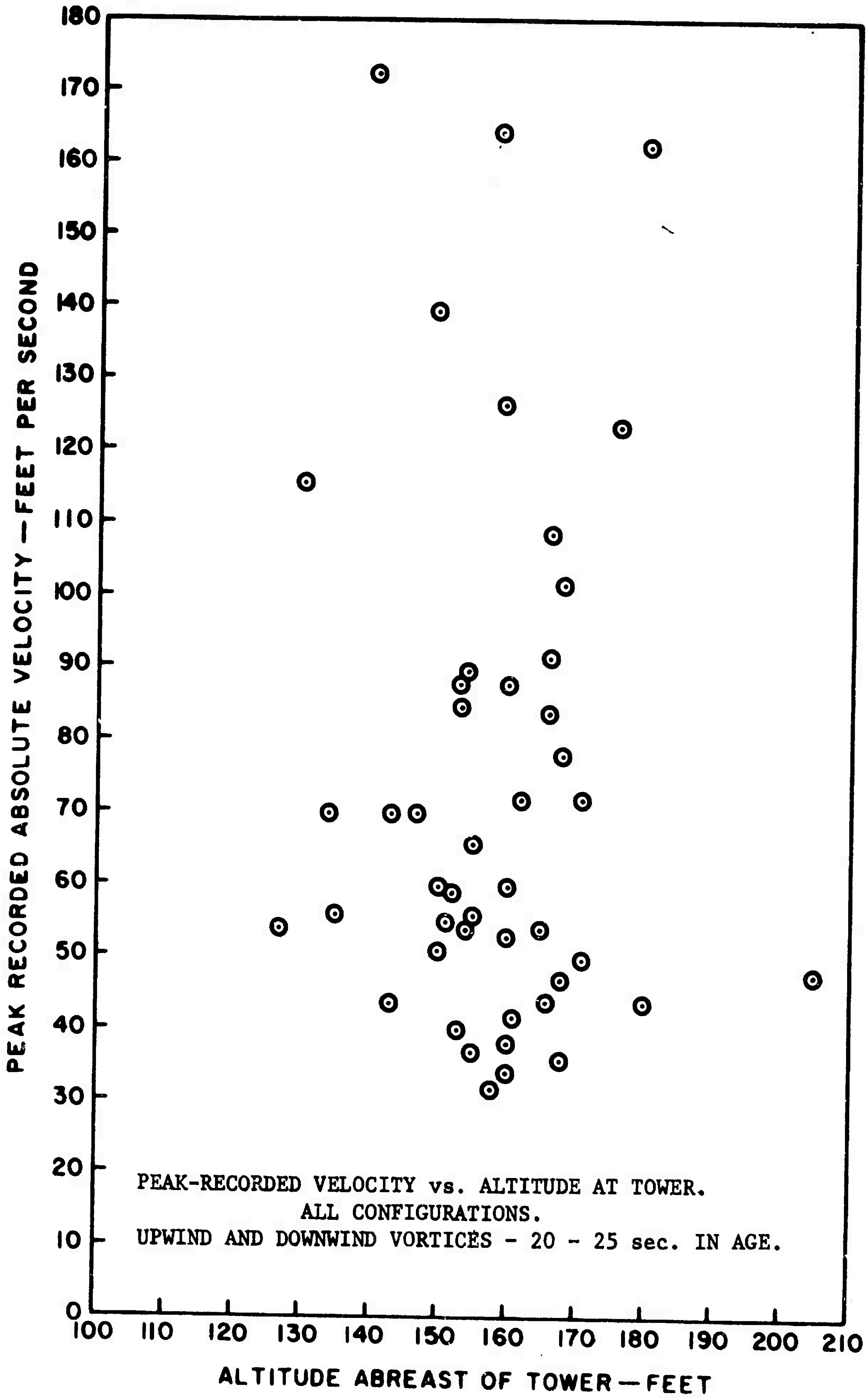
VORTEX LATERAL VELOCITY vs. CROSSWIND VELOCITY COMPONENT.
LANDING CONFIGURATION - UPWIND VORTICES.
VORTEX LATERAL VELOCITY — FEET PER SECOND
CROSSWIND VELOCITY COMPONENT — FEET PER SECOND
0
10
20
30
0
10
20
30

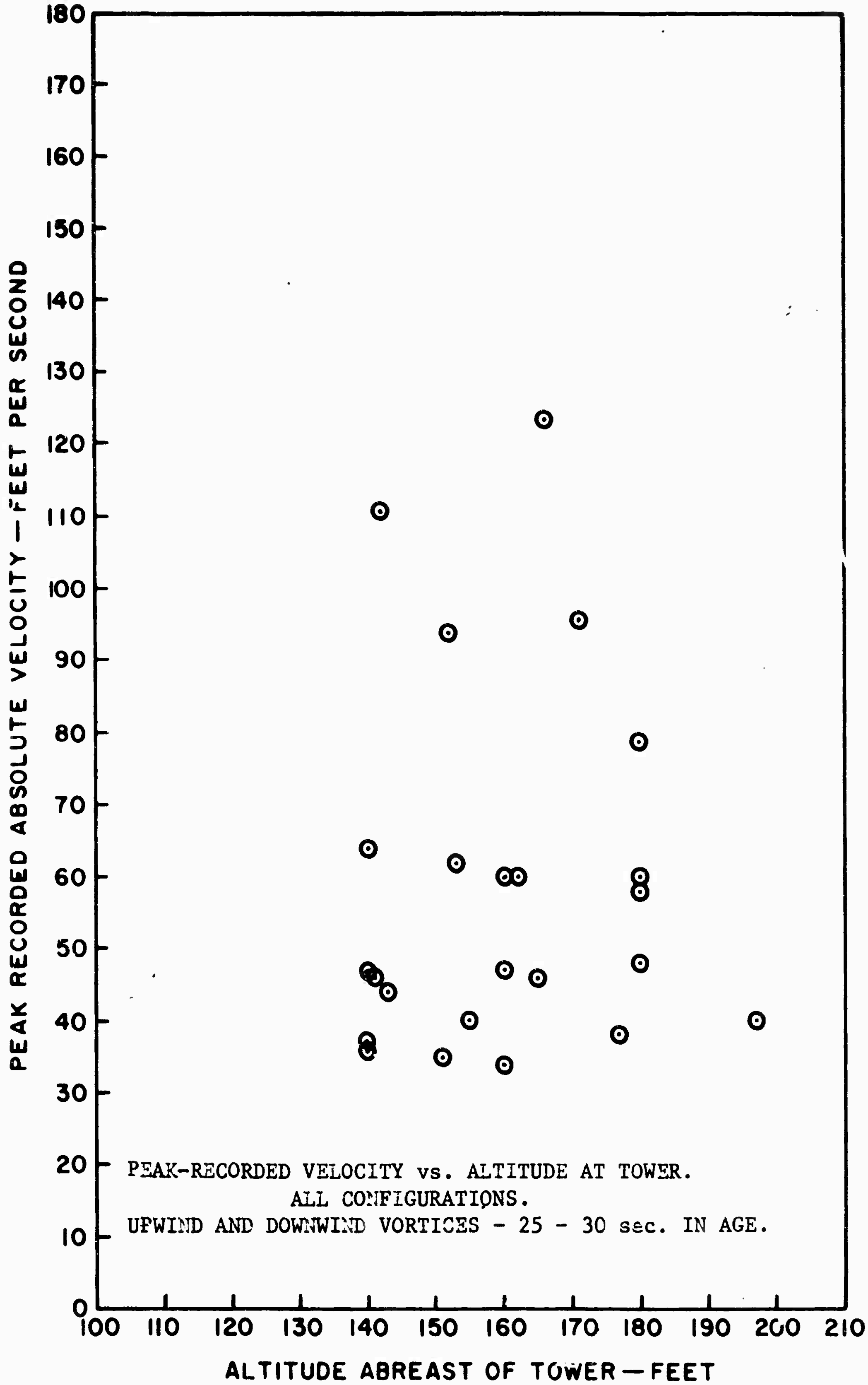

PEAK-RECORDED VELOCITY vs. ALTITUDE AT TOWER.
ALL CONFIGURATIONS.
UPWIND AND DOWNWIND VORTICES - ZERO - 10 sec. IN AGE.
PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
100
110
120
130
140
150
160
170
180
190
200
210
ALTITUDE ABREAST OF TOWER — FEET


PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
PEAK-RECORDED VELOCITY vs. ALTITUDE AT TOWER.
ALL CONFIGURATIONS.
UPWIND AND DOWNWIND VORTICES - 10 - 15 sec. IN AGE.
100
110
120
130
140
150
160
170
180
190
200
210
ALTITUDE ABREAST OF TOWER — FEET

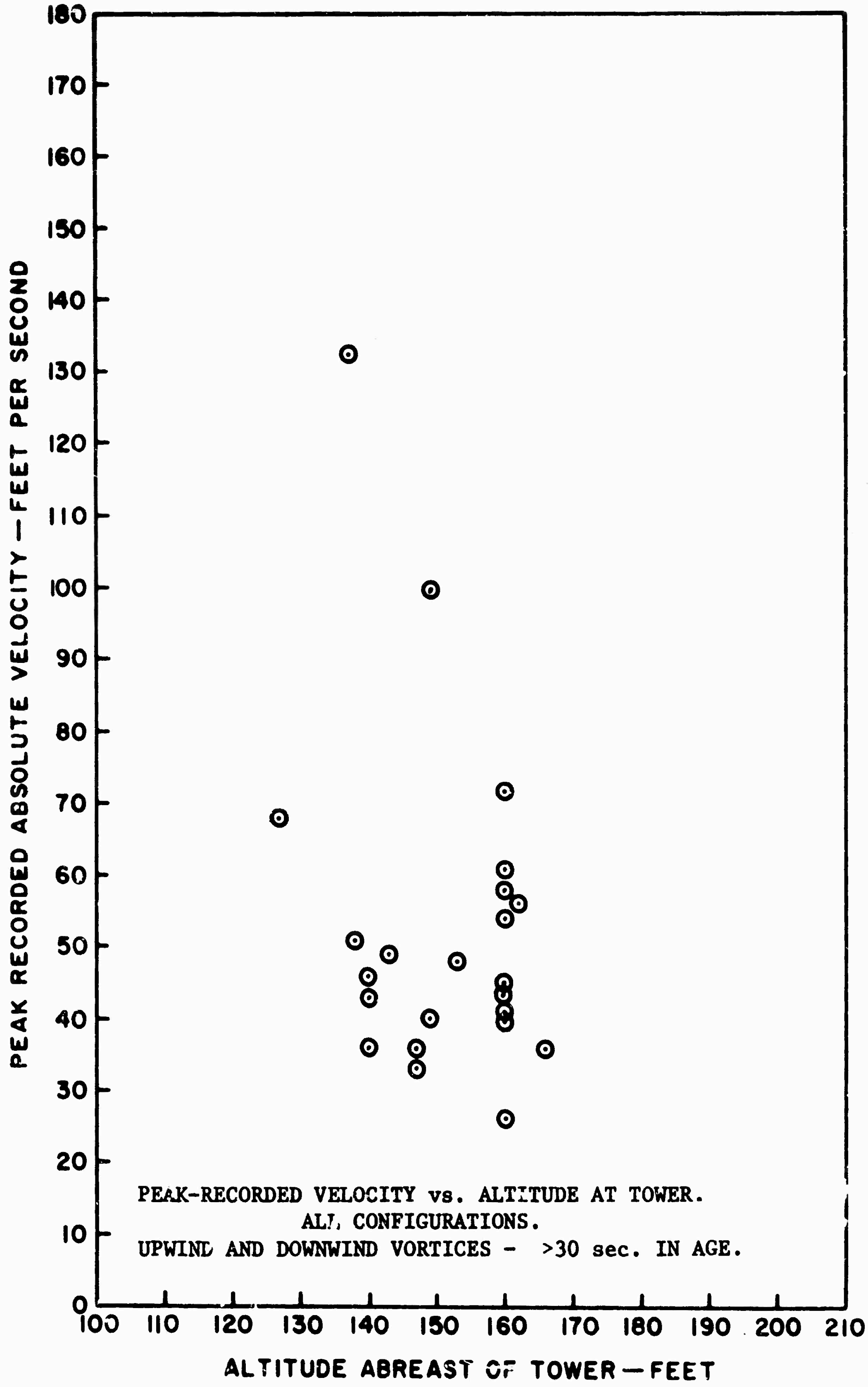


PEAK-RECORDED VELOCITY vs. ALTITUDE AT TOWER.
ALL CONFIGURATIONS.
UPWIND AND DOWNWIND VORTICES - 15 - 20 sec. IN AGE.


PEAK RECORDED ABSOLUTE VELOCITY — FEET PER SECOND
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
PEAK-RECORDED VELOCITY vs. ALTITUDE AT TOWER.
ALL CONFIGURATIONS.
UPWIND AND DOWNWIND VORTICES - 20 - 25 sec. IN AGE.
100
110
120
130
140
150
160
170
180
190
200
210
ALTITUDE ABREAST OF TOWER — FEET



PEAK-RECORDED VELOCITY vs. ALTITUDE AT TOWER.
ALL CONFIGURATIONS.
UPWIND AND DOWNWIND VORTICES - 25 - 30 sec. IN AGE.



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